Total Maximum Daily Loads for the Ottawa River (Lima Area) Watershed

Draft Report for Public Review
Division of Surface Water
April 19, 2013

Photo caption: Ottawa River upstream from State Route 224 near Kalida.

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Acronyms and Abbreviations

AFG	allowance for future growth
ALU	aquatic life use
AU	assessment unit
AWS	agricultural water supply
BMP	best management practices
BNA	base neutral and acid extractable compounds
BW	bathing water
CAFO	confined animal feeding operation
CFR	Code of Federal Regulations
cfs	cubic feet per second
Corps	United States Army Corps of Engineers
CREP	Conservation Reserve Enhancement Program (USDA program)
CRP	Conservation Reserve Program (USDA program)
CSO	combined sewer overflow
CSP	Conservation Security Program (USDA program)
CWA	Clean Water Act
CWH	coldwater habitat
D.O.	dissolved oxygen
DA	drainage area
DMR	discharge monitoring report
DNAP	Division of Natural Areas and Preserves (part of ODNR)
DOW	Division of Wildlife (part of ODNR)
DSW	Division of Surface Water (part of Ohio EPA)
DSWR	Division of Soil and Water Resources (part of ODNR)
ECBP	Eastern Corn Belt Plains (ecoregion)
EPA	Environmental Protection Agency, see U.S. EPA
EQIP	Environmental Quality Incentive Plan (USDA program)
EWH	exceptional warmwater habitat
FCA	fish consumption advisory
FFY	federal fiscal year (October 1 to September 30)
FSA	Farm Service Agency
FWPCA	Federal Water Pollution Control Act
gpd	gallons per day
GRP	Grassland Reserve Program (USDA program)
HELP	Huron Erie Lake Plain (ecoregion)
HSTS	home sewage treatment system
HU	hydrologic unit
HUC	hydrologic unit code
I/I	infiltration and inflow
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IR	Integrated Report
IWS	industrial water supply
kg	kilogram
L	liter
LA	load allocation
LaMP	Lakewide Management Plan
LEC	(Ohio) Lake Erie Commission

LEL	lowest effect level
LEPF	Lake Erie Protection Fund (LEC program)
LRAU	large river assessment unit
LRW	limited resource water
LTCP	long-term control plan
mg	milligram
MGD	million gallons per day
MHP	mobile home park
MIwb	Modified Index of well being
mi^2	square miles
ml	milliliter
MOS	margin of safety
MPN	most probable number
MS4	municipal separate storm sewer system
MWH	modified warmwater habitat
n	number (of data points in a grouping)
NHD	National Hydrography Dataset
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
ODA	Ohio Department of Agriculture
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
Ohio EPA	Ohio Environmental Protection Agency (preferred nomenclature)
ORC	Ohio Revised Code
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	on-site coordinator
OSUE	Ohio State University Extension
OWDA	Ohio Water Development Authority
OWRC	Ohio Water Resources Council
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCR	primary contact recreation
PEC	probable effect concentration
PDWS	public drinking water supply
PEC	probable effect concentration
ppb	parts per billion
PS	point source
PTI	permit to install
PTO	permit to operate
PWS	public water supply
QA	quality assurance
QC	quality control
QHEI	qualitative habitat evaluation index
RM	river mile
SCR	secondary contact recreation
SDWA	Safe Drinking Water Act

SEL	severe effect level
SFY	state fiscal year (July 1 to June 30)
SMP	sludge management plan
sq mi	square miles
SRW	state resource water
SSH	seasonal salmonid habitat
SSM	single-sample maximum
SSO	sanitary sewer overflow
STORET	STOrage and RETrieval (a U.S. EPA water quality database)
SWIMS	Surface Water Information Management System
SWCD	Soil and Water Conservation District
TEC	threshold effect concentration
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
ug	microgram
µg	microgram
U.S. EPA	United States Environmental Protection Agency
UAA	use attainability analysis
USACOE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compound
WAU	watershed assessment unit
WHIP	Wildlife Habitat Incentives Program (USDA program)
WLA	wasteload allocation
WPCLF	Water Pollution Control Loan Fund
WQ	water quality
WQS	water quality standards
WRP	Wetland Reserve Program (USDA program)
WRRSP	Water Resource Restoration Sponsor Program (Ohio EPA program)
WTP	water treatment plant
WWH	warmwater habitat
WWTP	wastewater treatment plant

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Executive Summary

The Ottawa River (Lima area) watershed is located in northwest Ohio extending from western Hardin County to the Auglaize River. This 365-square mile watershed area is home to more than 130,000 people and encompasses all or part of ten municipalities in Hardin, Allen, Putnam, Hancock and Auglaize counties. The watershed is primarily cultivated crop land and developed land.

State wide map of the Ottawa River (Lima area) watershed with the TMDL project area highlighted.

In 2010, Ohio EPA sampled 79 sites on streams in this watershed. Data collected related to water and sediment quality, aquatic biological communities, and habitat. Ohio's water quality standards were compared with these data to determine if quality criteria for various designated beneficial uses are being met.

Overall the watershed met criteria for the recreation use at 9 percent and 68 percent for aquatic life uses. Only the Ottawa River mainstem was impaired for the human health use; data were insufficient to assess support of the public drinking water supply use. The causes of impairments included dissolved oxygen (minima and ranges), nutrients, organic enrichment, total suspended solids, sedimentation/siltation, direct habitat alterations, nutrient/eutrophication biological indicators, fish kills, excess algal growth, low flow alterations, total ammonia, other anthropogenic substrate alterations, unknown, biochemical oxygen demand, fish-passage barrier, carbonaceous biochemical oxygen demand and *E. coli*. Sources of these stressors include flow alteration from water diversion, dams or impoundments, crop production with subsurface drainage, storm sewer overflows (SSOs), combined sewer overflows (CSOs), historic bottom deposits, municipal point source discharges, industrial point source discharges, unknown sources, urban runoff/storm sewers, streambank destabilization (from riparian removal), other spill-related impacts, unspecified domestic waste from pipe break, failing home sewage treatment systems (HSTS) and channelization (historic and current).

Total maximum daily loads (TMDL) have been developed for pollutants and stressors that have impaired beneficial uses and precluded attainment of applicable water quality standards. Specific TMDLs that have been developed and are described in this report include:

- Total phosphorus
- Carbonaceous biochemical oxygen demand (5-day)
- Habitat
- Sediment
- *E. coli* bacteria

The needed load reductions ranged from 0 to 82.4 percent for total phosphorus, five CSO excursions per year for $CBOD_5$ (a total overflow volume reduction of 81.1 percent) and 0 to 98.7 percent for *E. coli*. Sources of the pollutants that have been allocated the most significant reductions include municipal wastewater treatment plants, CSOs and cultivated crop lands.

Recommendations for regulatory action resulting from this TMDL analysis include lower effluent limits for total phosphorus and finalizing and implementing a long-term control plan to address Lima's CSOs. Nonpoint sources of nutrients should be addressed by planting winter cover crops, better managing nutrient application and reducing manure-laden runoff; for habitat and sediment by installing riparian woody vegetation and grassed waterways; and for organic enrichment by implementing storm water best management practices that increase infiltration.

1 INTRODUCTION

The Ottawa River (Lima area) watershed is located in northwest Ohio in Allen, Putnam and Hardin counties. Small portions of the watershed extend into Hancock and Auglaize counties as well. The watershed drains 365 square miles and flows into the Auglaize River north of Lima, Ohio. Ohio EPA sampled the watershed to assess biology, chemistry and physical habitat in 2010. Major causes of impairment include nutrients, flow alteration, low dissolved oxygen and *E. coli* bacteria. Probable sources of these impairments include impoundments from dams, crop production with subsurface drainage, urban runoff, combined sewer overflows and failing home sewage treatment systems (HSTS).

1.1 The Clean Water Act Requirement to Address Impaired Waters

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these impaired waters (the Section 303(d) lists) are made available to the public for comment, then submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval in even-numbered years. Further, the CWA and U.S. EPA regulations require that total maximum daily loads (TMDLs) be developed for all waters on the Section 303(d) lists. The Ohio EPA identified the Ottawa River (Lima area) watershed (assessment units 04100007 03 01 through 03 06, 04 01 through 04 06 and 05 01 through 05 03) as impaired on the 2012 303(d) list (Ohio EPA 2012; available at http://www.epa.ohio.gov/dsw/tmdl/OhioIntegratedReport.aspx).

In the simplest terms, a TMDL can be thought of as a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of water quality standards (WQS), which would subsequently lead to the removal of the waterbodies from the 303(d) list. Figure 1-1 shows the phases of TMDL development in Ohio.

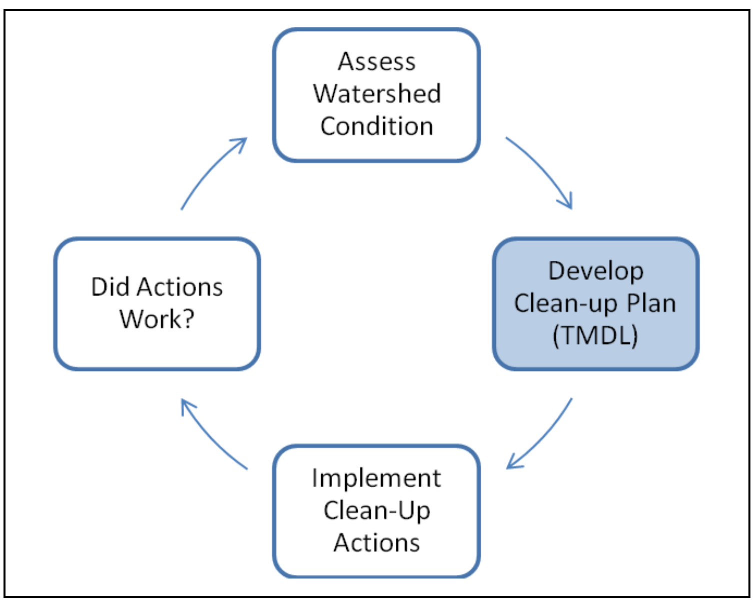


Figure 1-1. Overview of the TMDL project process.

Table 1-1 summarizes how the impairments identified in the Ottawa River (Lima area) watershed are addressed in this TMDL report.

Table 1-1. Summary of impairments in the Ottawa River (Lima area) watershed and methods used to address impairments.

Assessment Unit (04100007)	Narrative Description	Causes of Impairment (Beneficial use in parentheses)	Action Taken
Upper Ottawa River (04100007 03)			
03 01 *Priority points: 2*	Upper Hog Creek	No impairment (ALU)	No action necessary
		No data (RU)	No action necessary
03 02 *Priority points: 5*	Middle Hog Creek	No impairment (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
03 03 *Priority points: 9*	Little Hog Creek	Dissolved oxygen (ALU)	Total phosphorus TMDL
		Nutrients (ALU)	
		Organic enrichment (sewage) biological indicators (ALU)	
		Total suspended solids (ALU)	Sediment TMDL
		Sedimentation/siltation (ALU)	
		Direct habitat alterations (ALU)	Habitat TMDL
		Bacteria (RU)	*E. coli* TMDL
03 04 *Priority points: 9*	Lower Hog Creek	Nutrients (ALU)	Total phosphorus TMDL
		Nutrient/eutrophication biological indicators (ALU)	
		Sedimentation/siltation (ALU)	Sediment TMDL
		Bacteria (RU)	*E. coli* TMDL
03 05 *Priority points: 11*	Lost Creek	Fish kills (ALU)	Not addressed in this report
		Nutrients (ALU)	Total phosphorus TMDL
		Organic enrichment (sewage) biological indicators (ALU)	
		Bacteria (RU)	*E. coli* TMDL
		Insufficient data to assess use (PDWSU)	No action necessary
03 06 *Priority points: 8*	Lima Reservoir-Ottawa River	Dissolved oxygen (ALU)	Total phosphorus TMDL
		Nutrients (ALU)	
		Nutrient/eutrophication biological indicators (ALU)	
		Excess algal growth (ALU)	

Assessment Unit (04100007)	**Narrative Description**	**Causes of Impairment** (Beneficial use in parentheses)	**Action Taken**
		Low flow alterations (ALU)[1]	
		Organic enrichment (sewage) biological indicators (ALU)	$CBOD_5$ TMDL
		Ammonia (total) (ALU)	Not addressed in this report[2]
		Direct habitat alterations (ALU)	Habitat TMDL
		Other anthropogenic substrate alterations (ALU)	Sediment TMDL
		Sedimentation/siltation (ALU)	
		Unknown (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
		Insufficient data to assess use (PDWSU)	No action necessary
Middle Ottawa River (04100007 04)			
04 01 *Priority points: 6*	Little Ottawa River	Biochemical oxygen demand (ALU)	Total phosphorus TMDL
		Nutrients (ALU)	
		Organic enrichment (sewage) biological indicators (ALU)	
		Direct habitat alterations (ALU)	Sediment TMDL
		Bacteria (RU)	*E. coli* TMDL
04 02 *Priority points: 10*	Dug Run-Ottawa River	Dissolved oxygen (ALU)	Total phosphorus TMDL
		Nutrient/eutrophication biological indicators (ALU)	
		Nutrients (ALU)	
		Organic enrichment (sewage) biological indicators (ALU)	$CBOD_5$ TMDL
		Fish-passage barrier (ALU)[3]	Not addressed in this report
		Unknown (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
04 03 *Priority points: 7*	Honey Run	Dissolved oxygen (ALU)	Total phosphorus TMDL
		Nutrients (ALU)	
		Direct habitat alterations (ALU)	Habitat TMDL
		Bacteria (RU)	*E. coli* TMDL
		Insufficient data to assess use (PDWSU)	No action necessary

Assessment Unit (04100007)	**Narrative Description**	**Causes of Impairment** (Beneficial use in parentheses)	**Action Taken**
04 04 *Priority points: 3*	Pike Run	No impairment (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
04 05 *Priority points: 5*	Leatherwood Ditch	No impairment (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
04 06 *Priority points: 6*	Beaver Run-Ottawa River	No impairment (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
Lower Ottawa River (04100007 05)			
05 01 *Priority points: 5*	Sugar Creek	No impairment (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL
05 02 *Priority points: 9*	Plum Creek	Fish kills (ALU)	Not addressed in this report
		Dissolved oxygen (ALU)	Total phosphorus TMDL
		Biochemical oxygen demand (ALU)	
		Nutrient/eutrophication biological indicators (ALU)	
		Ammonia (total) (ALU)	
		Organic enrichment (sewage) biological indicators (ALU)	
		Sedimentation/siltation (ALU)	Sediment and habitat TMDLs
		Unknown (ALU)	Not addressed in this report
		Bacteria (RU)	*E. coli* TMDL
05 03 *Priority points: 6*	Village of Kalida-Ottawa River	No impairment (ALU)	No action necessary
		Bacteria (RU)	*E. coli* TMDL

ALU = aquatic life use
RU = recreation use
PDWSU = public drinking water supply use

[1] Only addressed problems where lowhead dams exacerbate nutrient enrichment. Lowhead dams place a physical restriction on the macroinvertebrate community that is not addressed by the proposed technique.

[2] Impairment is linked to permit exceedances from a point source near the time of sampling based on a mechanical error at the facility. Repetition of the error is not expected. Current permit limits are considered protective of aquatic life.

[3] A fish passage barrier is not a load-regulated impairment and thus a TMDL is inappropriate.

1.2 Public Involvement

Public involvement is fundamental to the success of water restoration projects, including TMDL efforts. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. The Ohio EPA convened an external advisory group in 1998 to assist the Agency with the development of the TMDL program in Ohio. The advisory group issued a report in July 2000 to the Director of Ohio EPA on their findings and recommendations. The Ottawa River (Lima area) watershed TMDL project has been completed using the process endorsed by the advisory group.

The Ottawa River Coalition has been an active group of partners from the watershed and the city of Lima since 1995. They employ a watershed coordinator who has been involved with past 319 implementation grants and other federal, state and locally funded water quality improvement projects. The coordinator facilitated a meeting of the coalition to provide input to our TMDL assessment and then attended our pre-field season planning meeting in April 2010.

Following completion of the TMDL assessment work in the summer of 2010, the Ohio EPA and other state agencies were invited to participate in a dam forum on December 8, 2010. Specifically the city of Lima was interested in the status of several low head dams located along the mainstem of the Ottawa River through the city. City officials made a clear argument for retaining certain dams, and agreed that hydrology study of the Allentown dam was advisable.

Ohio EPA met with citizens, city and county officials, consultants and conservation groups on March 23, 2011 to present the preliminary findings of the water quality survey as they related to the mainstem of the Ottawa River.

The Ottawa River Coalition hosted the public information sessions in the morning and evening of June 20, 2012 in which Ohio EPA asked for public suggestion and comments on the draft implementation plan. Representatives of Ohio EPA participated in the outdoor watershed information event on the river in downtown Lima during the afternoon. An electrofishing demonstration was completed during the event, at which time Ohio EPA biologists discussed the improving trends in the aquatic biology and water quality in the Ottawa River.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report will be available for public comment from April 19 through May 20, 2013. A copy of the draft report will be posted on Ohio EPA's web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx).

Continued public involvement is essential to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate, to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the need for voluntary actions facilitated by the local stakeholders, watershed organization, and agency partners to restore the Ottawa River (Lima area) watershed.

1.3 Organization of Report

Chapter 2 gives an overview of water quality standards applicable in the watershed. Chapter 3 gives an overview of the water quality conditions in the watershed. Chapter 4 briefly discusses the methods used to calculate load reductions. Chapter 5 provides the load reduction results. Chapter 6 discusses suggested restoration methods to improve water quality.

More detailed information on selected topics is contained in appendices. Appendix A lists the permitted facilities in the watershed. Appendix B summarizes the findings of the watershed survey. Appendix C is a primer on Ohio's water quality standards. Appendix D contains details of the loading analysis. Appendix E discusses programs and actions available to improve water quality.

Readers may also wish to consult the technical glossary and background information available on Ohio EPA's TMDL Web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx).

2 CHARACTERISTICS AND EXPECTATIONS OF THE WATERSHED

The Ottawa River (Lima area) watershed is located in northwest Ohio in Allen, Putnam and Hardin counties. Small portions of the watershed extend into Hancock and Auglaize counties as well. The watershed drains 365 square miles and flows into the Auglaize River north of Lima, Ohio. The major municipality in the watershed is the city of Lima. Smaller municipalities include Kalida, Columbus Grove, Elida and Ada.

2.1 Watershed Characteristics

The following subsections provide an overview of the characteristics of the Ottawa River (Lima area) watershed.

2.1.1 Population and Distribution

Hardin County's population increased slightly (0.4 percent) between 2000 and 2010[1]. Population declined in Allen and Putnam counties (-2.0 and -0.7 percent, respectively) and the city of Lima. Population change predictions from 2010 to 2020 are not yet available from the U.S. Census Bureau.

[1] Source: http://quickfacts.census.gov/qfd/index.html

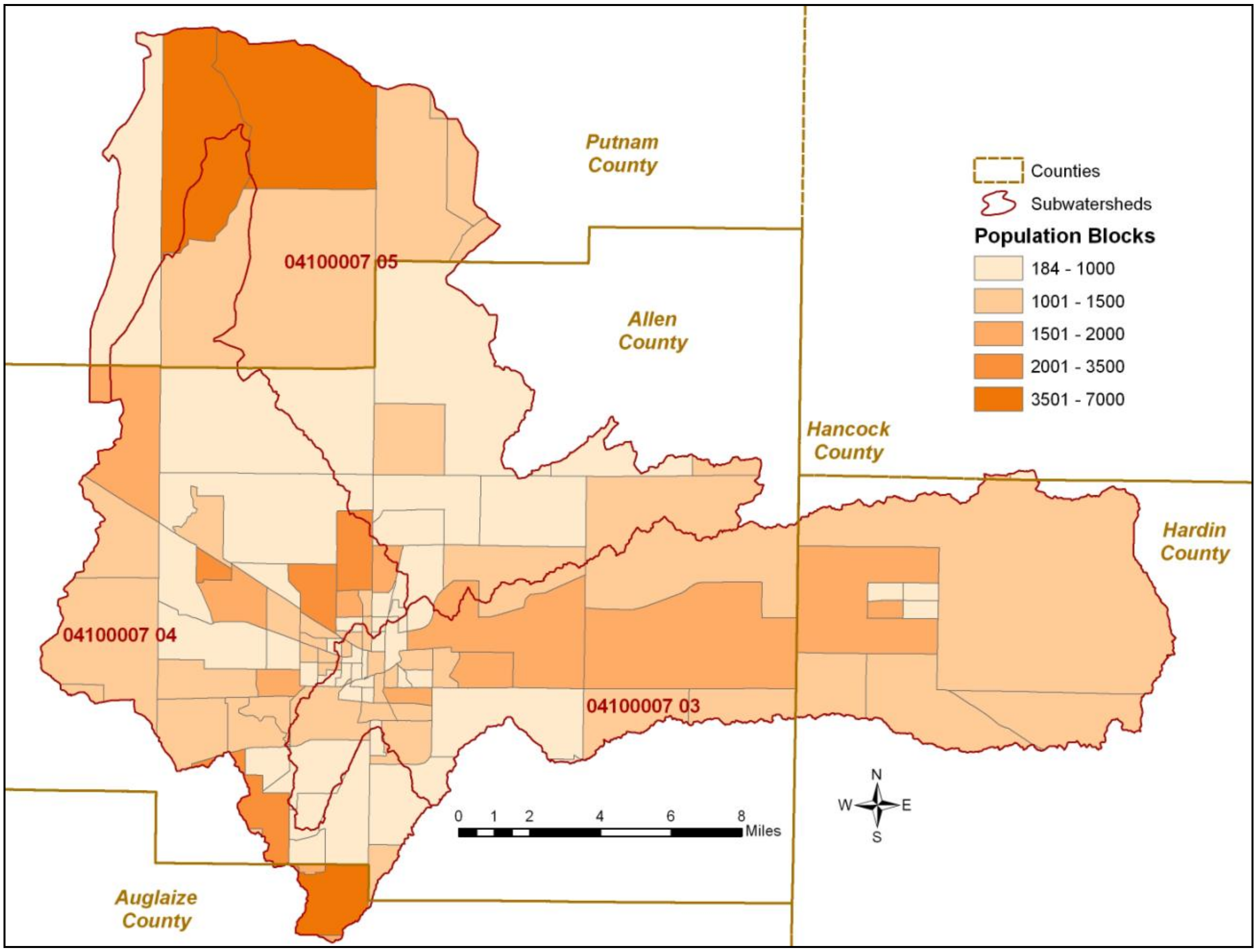


Figure 2-1. Population blocks in the Ottawa River (Lima area) watershed.

2.1.2 Land Use

The Lima area is highly developed. There are several other developed areas in the small towns around the watershed. The remainder of the watershed is primarily cultivated crop land (see Figure 2-2).

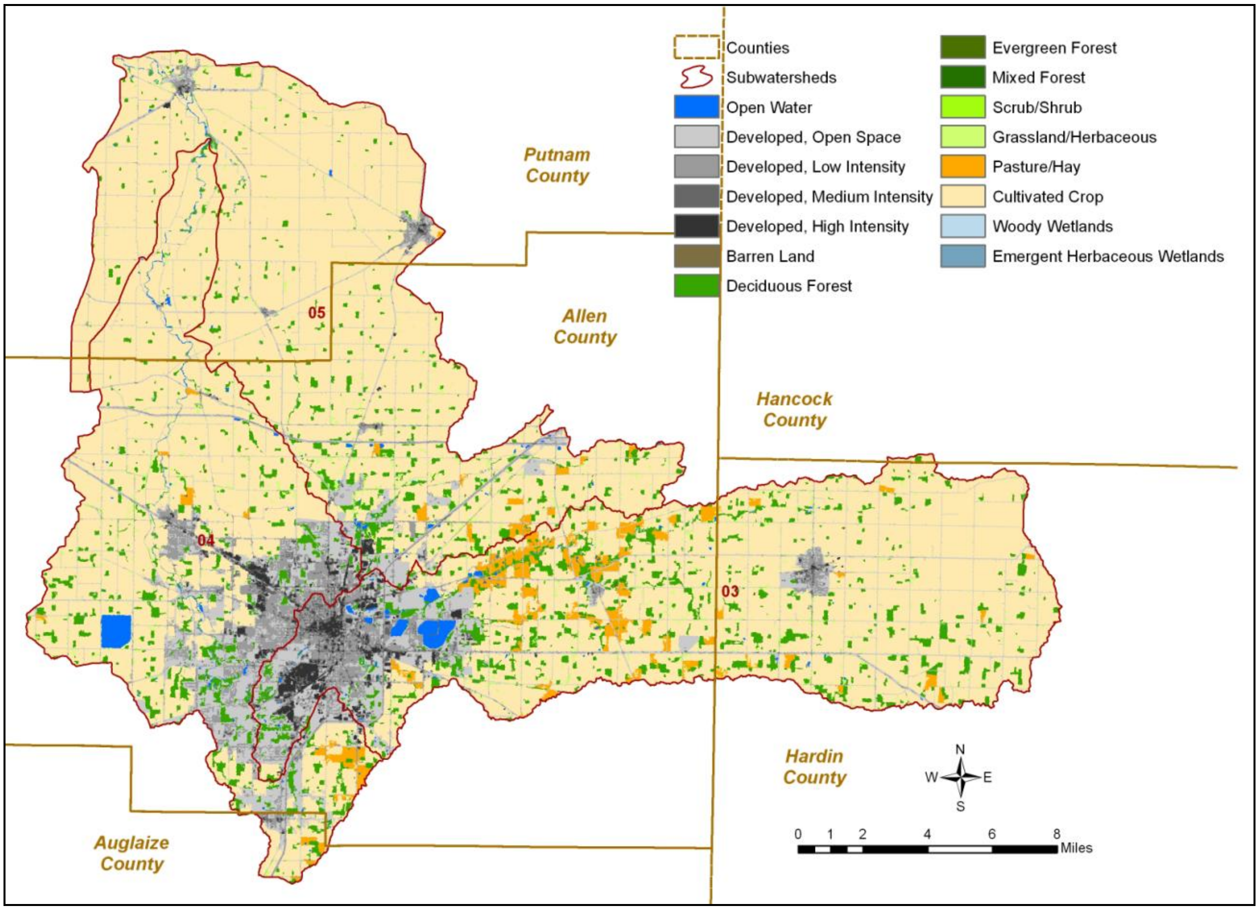


Figure 2-2. Land use in the Ottawa River (Lima area) watershed.

2.1.3 Point Source Discharges

Industrial and municipal point sources include wastewater treatment plants and factories. Wastewater treatment plants can contribute to bacteria, nutrient enrichment, siltation, and flow alteration problems. Industrial point sources, such as factories, sometimes discharge water that is excessively warm or cold, changing the temperature of the stream. Point sources may contain other pollutants such as chemicals and metals.

NPDES dischargers are entities that possess a permit through the National Pollutant Discharge Elimination System (NPDES). NPDES permits limit the quantity of pollutants discharged and impose monitoring requirements. NPDES permits are designed to protect public health and the aquatic environment by helping to ensure compliance with state and federal regulations. NPDES entities generally discharge wastewater continuously. They primarily affect water quality under average- to low-flow conditions because the potential for dilution is lower. NPDES dischargers located near the origin of a stream or on a small tributary are more likely to cause severe water quality problems because their effluent can dominate the natural stream flow. Appendix A lists the NPDES permittees in the Ottawa River (Lima area) watershed.

Most individual permits are located in the vicinity of Lima, though others are scattered throughout the watershed. The combined design flow of the facilities is nearly 39 million gallons per day (MGD), not including storm water permits. The largest dischargers include the Lima wastewater treatment plant (WWTP), Lima Refinery and PCS Nitrogen; their processes are summarized below. There are 13 municipal facilities and 20 industrial ones. Two of the industrial facilities are major dischargers (design flow of more than one MGD) and four of the municipal facilities are major dischargers.

Nutrient TMDL analyses in this report do not examine wet weather conditions in the Ottawa River mainstem, nor do they negate previous work done on wet weather issues in the mainstem. Instead, the nutrient TMDL on the mainstem of the Ottawa River through Lima focuses on critical low flows.

City of Lima WWTP (2PE00000) – A major municipal facility that discharges to the Ottawa River at RM 37.6, the Lima WWTP is an activated sludge plant with an average daily design flow of 18.5 MGD and a hydraulic capacity of 45 MGD. Wet stream processes include screening and grit removal, phosphorus removal using ferrous chloride and polymer addition, primary settling, activated sludge aeration, secondary clarification, nitrification using trickling filters, disinfection by chlorination and dechlorination. Solid stream processes are sludge thickening, stabilization by anaerobic digestion, dewatering by belt filter press, alkaline stabilization, and sludge disposal at a landfill and by marketing.

Lima Refining Company (Husky Refinery) (2IG00001) – A major industrial facility that discharges at RM 37.1 to the Ottawa River via Outfall 001, the Lima/Husky Refinery produces a variety of products from crude oil including gasoline, diesel fuel, jet fuel, liquid propane gas, coke, benzene, toluene and trolumen (oxidized asphalt). Process operations include crude distillation, crude desalting, fluid catalytic cracking, hydrocracking, delayed coking and catalytic reforming.

PCS Nitrogen (2IF00004) – A major discharger, PCS Nitrogen, has four outfalls that discharge to the Ottawa River at river mile (RM) 36.9. PCS Nitrogen manufactures ammonia and several other products that use ammonia as a raw material. Ammonia, urea, nitric acid, ammonium nitrate and nitrogen fertilizer solutions are manufactured at the Lima facility. In addition, carbon dioxide is produced as a co-product of ammonia manufacturing and is processed by BOC Gas, Inc.

2.1.4 Public Drinking Water Supplies

Some communities supply public drinking water from ground water (underground aquifers). Other communities supply public drinking water by withdrawing water from surface waters, including lakes and streams. Surface water public drinking water supplies for the city of Lima are located in the watershed. More details are available in Appendix B.

2.2 Water Quality Standards

TMDLs are required when a waterbody fails to meet water quality standards (WQS). Every state must adopt WQS to protect, maintain, and improve the quality of the nation's surface waters. WQS represent a level of water quality that will support the Clean Water Act goal of swimmable and fishable waters. Ohio's WQS, set forth in Chapter 3745-1 of the Ohio Administrative Code (OAC), include three major components: beneficial use designations, numeric and narrative criteria and antidegradation provisions. Where criteria have not been developed, the State can develop project-specific targets.

Beneficial use designations describe the existing or potential uses of a waterbody, such as public water supply; protection and propagation of aquatic life; and recreation in and on the water. Ohio EPA assigns beneficial use designations to each waterbody in the state. Use designations are defined in paragraph (B) of rule 3745-1-07 of the OAC and are assigned in rules 3745-1-08 to 3745-1-32. Attainment of uses is based on specific numeric and narrative criteria.

Numeric criteria are estimations of chemical concentrations, degree of aquatic life toxicity, and physical conditions allowable in a waterbody without adversely impacting its beneficial uses. Narrative criteria, located in rule 3745-1-04 of the OAC, describe general water quality goals 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. Much of Ohio EPA's present strategy regarding water quality based permitting is based upon the narrative free from of "no toxics in toxic amounts." Ohio EPA developed its strategy based on an evaluation of the potential for significant toxic impacts within the receiving waters. Very important components of this evaluation are the biological survey program and the biological criteria used to judge aquatic life use attainment.

Antidegradation provisions describe the conditions under which water quality may be lowered in surface waters. Under such conditions water quality may not be lowered below criteria protective of existing beneficial uses unless lower quality is deemed necessary to allow important economic or social development. Antidegradation provisions are in Sections 3745-1-05 and 3745-1-54 of the OAC.

The following sub-sections describe the applicable water quality standards for the Ottawa River (Lima area) watershed. Further details can be found in Appendix C.

2.2.1 Aquatic Life Use

Ohio's WQS have seven subcategories of aquatic life uses (see http://www.epa.ohio.gov/portals/35/rules/01-07.pdf). The WQS rule contains a narrative for each aquatic life use and the three most commonly assigned aquatic life uses have quantitative, numeric biological criteria that express the minimum acceptable level of biological performance based on three separate biological indices. The indices measure the health of aquatic communities of both fish and insects.

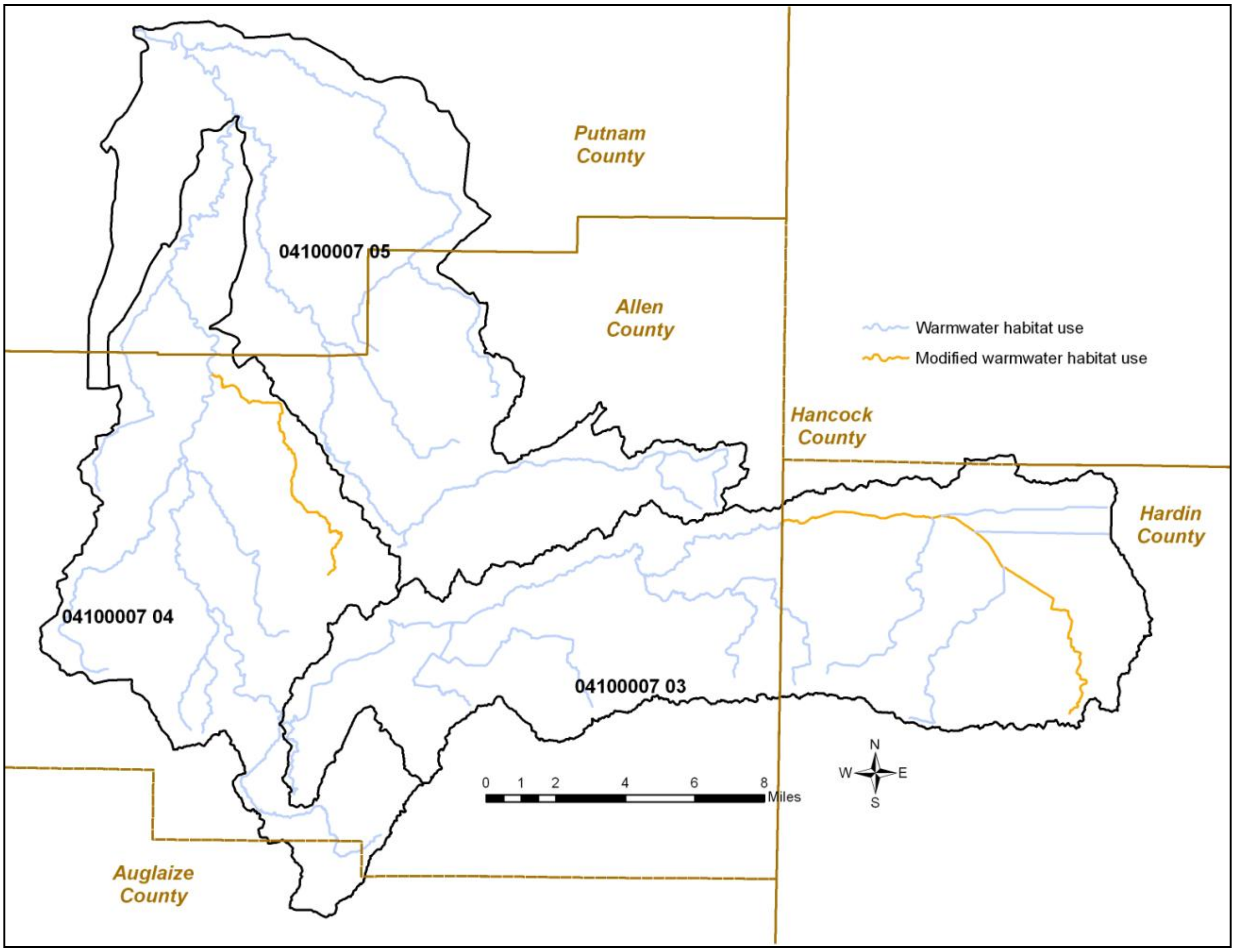


Figure 2-3. Aquatic life use designations in the Ottawa River (Lima area) watershed.

Table 2-1. Biological criteria for three aquatic life use designations.
Note: Criteria are established based on ecoregion and assessment method.

Ecoregion	Biological Index	Assessment Method[2, 3]	Biological Criteria for the Applicable Aquatic Life Use Designations[1]		
			WWH	EWH	MWH[4]
Eastern Cornbelt Plains (ECBP)	IBI	Headwater	40	50	24
		Wading	40	50	24
		Boat	42	48	24 / 30
	MIwb	Wading	8.3	9.4	6.2
		Boat	8.5	9.6	5.8 / 6.6
	ICI	All[5]	36	46	22
Huron-Erie Lake Plains (HELP)	IBI	Headwater	28	50	20
		Wading	32	50	22
		Boat	34	48	20 / 22
	MIwb	Wading	7.3	9.4	5.6
		Boat	8.6	9.6	5.7 / 5.7
	ICI	All[5]	34	46	22

[1] Coldwater habitats (CWH), limited warmwater habitat (LWH), resource waters (LRW) and seasonal salmonid habitat (SSH) do not have associated biological criteria.
[2] The assessment method used at a site is determined by its drainage area (DA) according to the following: Headwater: DA ≤ 20 mi^2; wading: DA >20 mi^2 and ≤ 500 mi^2; boat: DA > 500 mi^2
[3] MIwb not applicable to drainage areas less than 20 mi^2.
[4] Biocriteria depend on type of MWH. MWH-C (due to channelization) is listed first, MWH-I (due to impoundment) is listed second, and MWH-A (mine affected) is listed third (only applicable in the WAP).
[5] Limited to sites with appropriate conditions for artificial substrate placement.

2.2.2 Recreation Use

Ohio's WQS have three subcategories of recreation uses (bathing waters, primary contact and secondary contact). Within primary contact there are three classes of streams (A, B and C) that describe the general frequency with which the stream is used for recreation. The WQS rule contains a description of each recreation use and all primary contact recreation classes have numeric criteria that are associated with a statistically-based risk level.

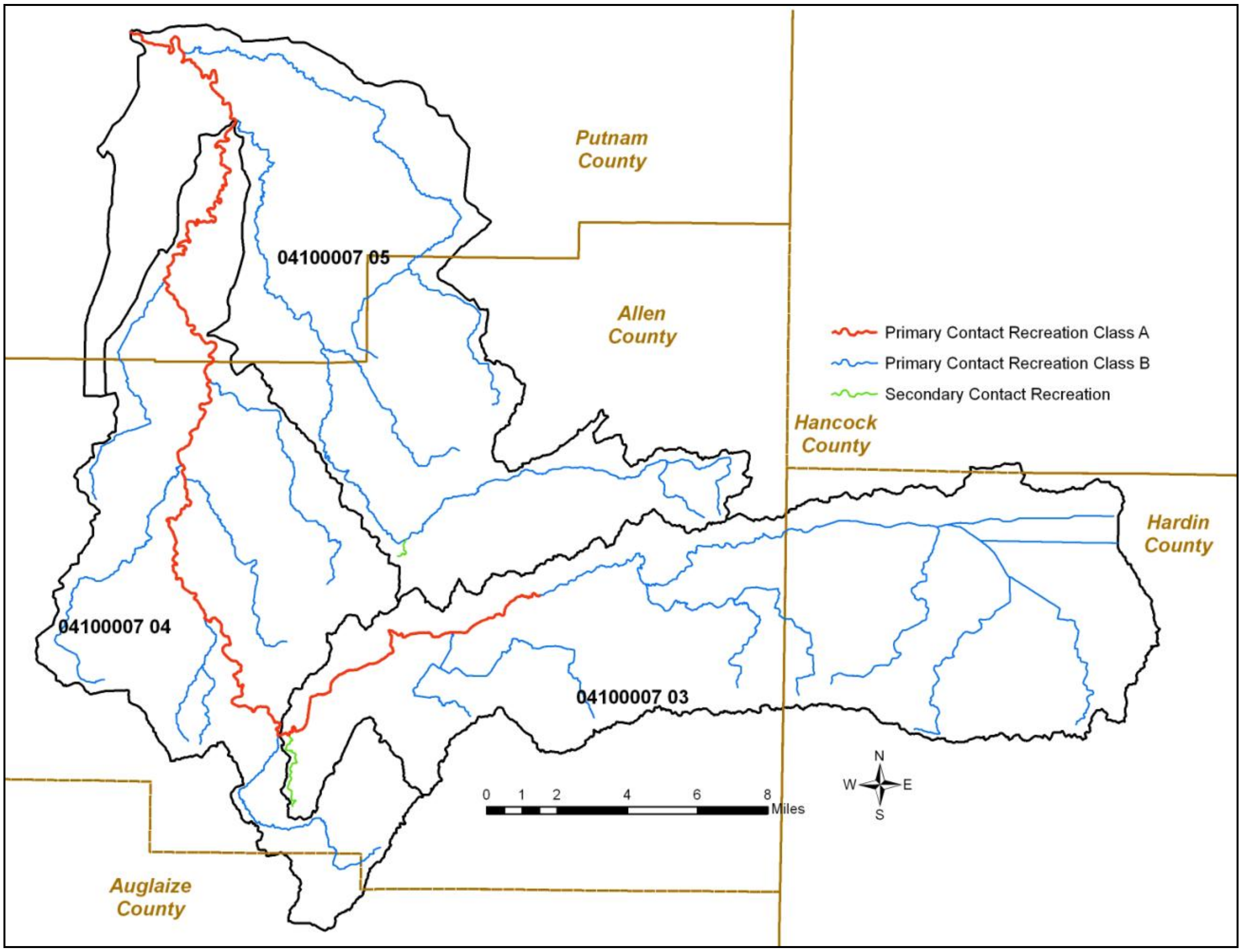


Figure 2-4. Recreation use designations in the Ottawa River (Lima area) watershed.

Table 2-2. Water quality criteria established for recreation uses within Ohio.

Recreation Use	*E. coli* (colony forming units per 100 ml)	
	Seasonal Geometric Mean	Single Sample Maximum[1]
Bathing water	126	235[a]
Class A primary contact recreation	126	298
Class B primary contact recreation	161	523
Class C primary contact recreation	206	940
Secondary contact recreation	1030	1030

[1] Except as noted in footnote *a*, these criteria shall not be exceeded in more than ten per cent of the samples taken during any thirty-day period.

[a] This criterion shall be used for the issuance of beach and bathing water advisories.

2.2.3 Public Drinking Water Supply Use

The public drinking water supply use includes surface waters from which public drinking water is supplied. This beneficial use provides an opportunity to strengthen the connection between Clean Water Act and Safe Drinking Water Act (SDWA) activities by employing the authority of the CWA to meet SDWA objectives of source water protection and reduced risk to human health. Criteria associated with this use designation apply within five hundred yards of surface water intakes.

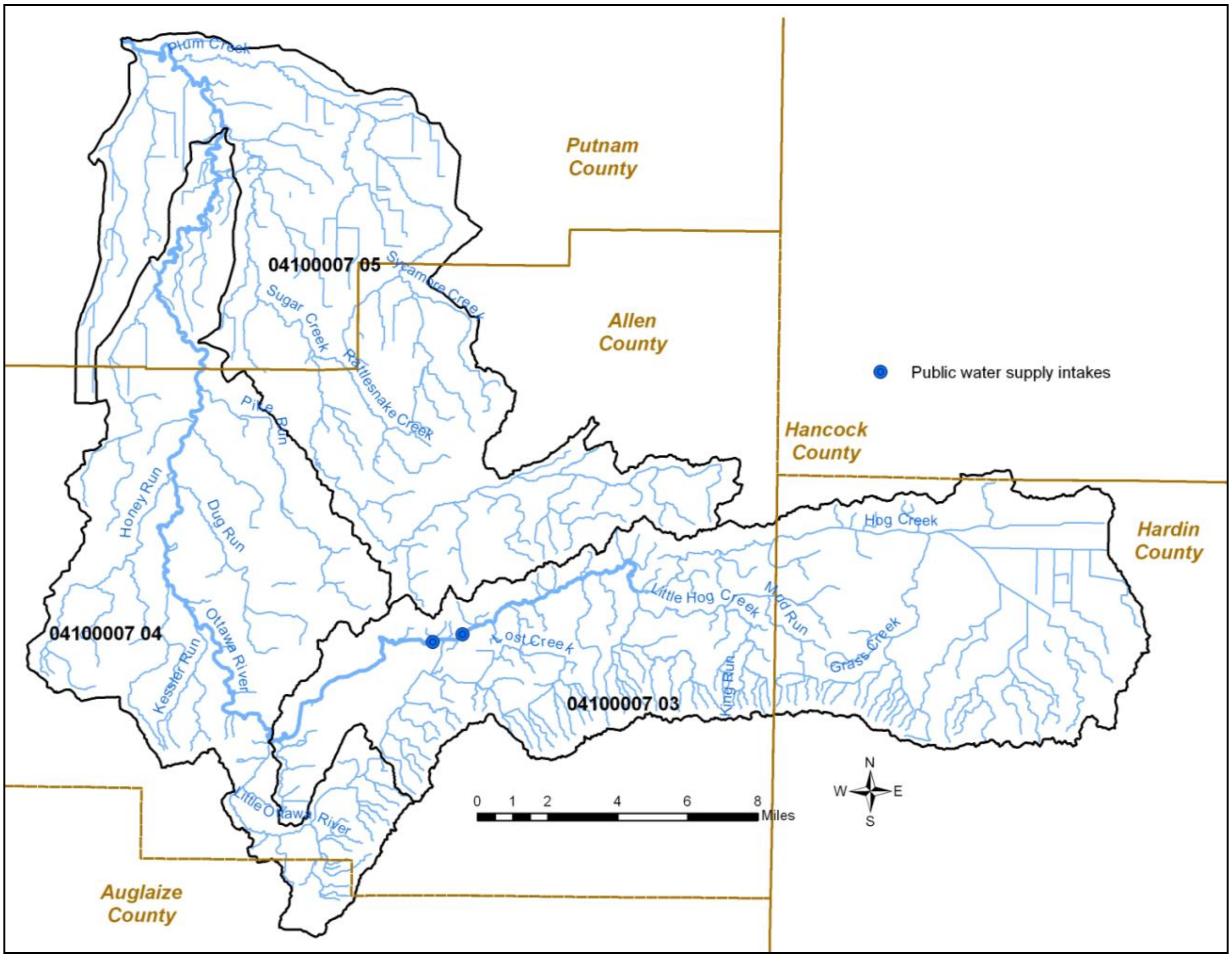


Figure 2-5. Public drinking water supplies in the Ottawa River (Lima area) watershed.

2.2.4 Human Health (Fish Contaminants) Use

Ohio has adopted human health WQS criteria to protect the public from adverse impacts, both carcinogenic and non-carcinogenic, caused by exposure via drinking water (applicable at public water supply intakes) and by exposure in the contaminated flesh of sport fish (applicable in all surface waters). The latter criterion, called the non-drinking water human health criterion, ensures that levels of a chemical in water do not bioaccumulate in fish to levels harmful to people who catch and eat the fish. Ohio measures contaminants in fish tissue and uses the data in two comparisons: (1) to determine if the human health criteria are being violated, thus identifying the water for restoration through a TMDL or other action, or (2) to determine the quantity of sport fish that may be safely consumed. The first comparison can result in the water being identified as impaired on the 303(d) list; the second can result in the issuance of a sport fish consumption advisory.

Fourteen sites were sampled in 2010 for fish tissue, allowing a human health use support assessment in two nested subwatersheds. One of those was fully supporting the use. The other (Lima Reservoir-Ottawa River) was not supporting the use because of PCBs.

Two common contaminants in fish tissue are polychlorinated biphenyls (PCBs) and mercury. PCBs are currently banned from use in the U.S. and are expected to decrease in streams over time. Therefore, no further action other than continued monitoring for PCBs in fish in Ottawa River (Lima area) watershed will be taken.

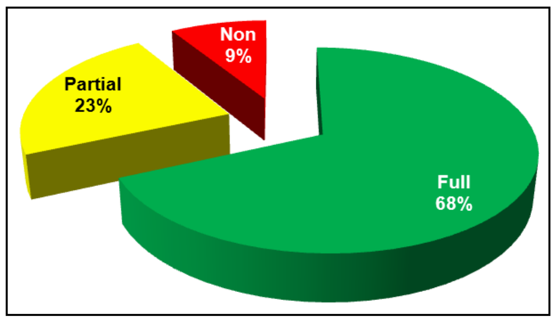
The Ottawa River (Lima area) watershed is included in the statewide fish advisory for mercury. Additional advisories specific to the Ottawa River (Lima area) watershed exist. Information regarding fish consumption advisories can be found at:
http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx.

3 WATER QUALITY CONDITIONS IN THE WATERSHED

Ohio uses the fish and aquatic insects that live in streams to assess the health of Ohio's flowing waters. Aquatic animals are generally the most sensitive indicators of pollution because they inhabit the water all of the time. A healthy stream community is also associated with high quality recreational opportunities (e.g., fishing and boating).

In addition to biological data, Ohio EPA collects information on the chemical quality of the water, sediment, and wastewater discharges; data on the contaminants in fish flesh; and physical information about streams. Taken together, this information identifies the factors that limit the health of aquatic life and that constitute threats to human health.

Ohio EPA performed a comprehensive water quality study in the Ottawa River (Lima area) watershed in 2010. Seventy-nine sites were evaluated for biological health, 75 sites for water chemistry, 20 sites for recreation use and 14 sites for human health (fish contaminants) use. Sites were scattered throughout the watershed but concentrated on the Ottawa River mainstem. Please refer to Appendix B for more detail.



Where aquatic life use impairment was documented upstream from the city of Lima, it was primarily caused by nutrients, sediment and habitat alteration from cultivated crop land uses. Impairment in and around the city of Lima was primarily caused by organic enrichment, nutrients, low dissolved oxygen and flow alteration stemming from municipal and industrial point sources, combined sewer overflows (CSOs), sanitary sewer overflows (SSOs) and dams. Aquatic life impairment downstream from the city of Lima was generally caused by nutrients, organic enrichment and sediment stemming from cultivated crop land uses, CSOs and municipal point source discharges. The pie chart to the right shows that 68 percent of sampled sites met all biological goals, 23 percent met some biological goals and 9 percent met no biological goals.

The Ottawa River (Lima area) watershed TMDL includes three subwatersheds (Figure 3-1). Within each of the three subwatersheds, smaller watersheds are nested (12-digit assessment units). This chapter discusses conditions in each of the subwatersheds. Overall, impairment for aquatic life and recreation uses was more common in the southern area of the watershed. Sources of impairment tended to change depending on land use, with sources related to cropland and home sewage treatment system (HSTS) in more rural areas and CSO and point source discharge-related sources in more urban areas.

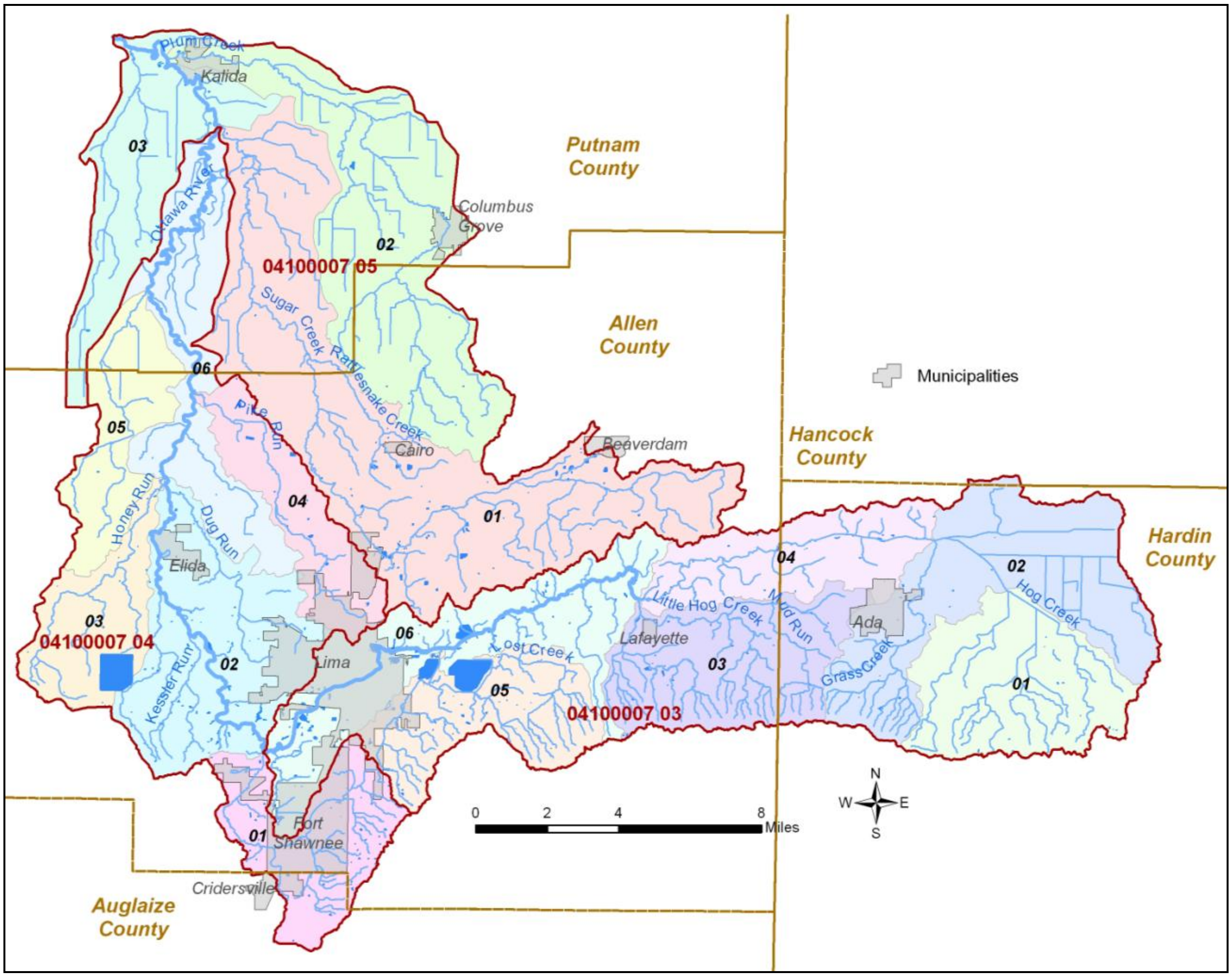


Figure 3-1. Map of the Ottawa River (Lima area) watershed.

3.1 Upper Ottawa River (04100007 03)

The Upper Ottawa River subwatershed drains 135.2 square miles in the southeastern portion of the watershed (see Figure 3-2). It consists of six nested subwatersheds. The main streams in the Upper Ottawa River subwatershed include Hog Creek, Little Hog Creek, Lost Creek and the Ottawa River. Major causes of impairment include nutrients, low dissolved oxygen (D.O.), organic enrichment, sedimentation/siltation and habitat alterations. Those causes are primarily associated with municipal and industrial point source discharges, a dam or impoundment, urban runoff/storm sewers, CSOs and crop production with subsurface drainage.

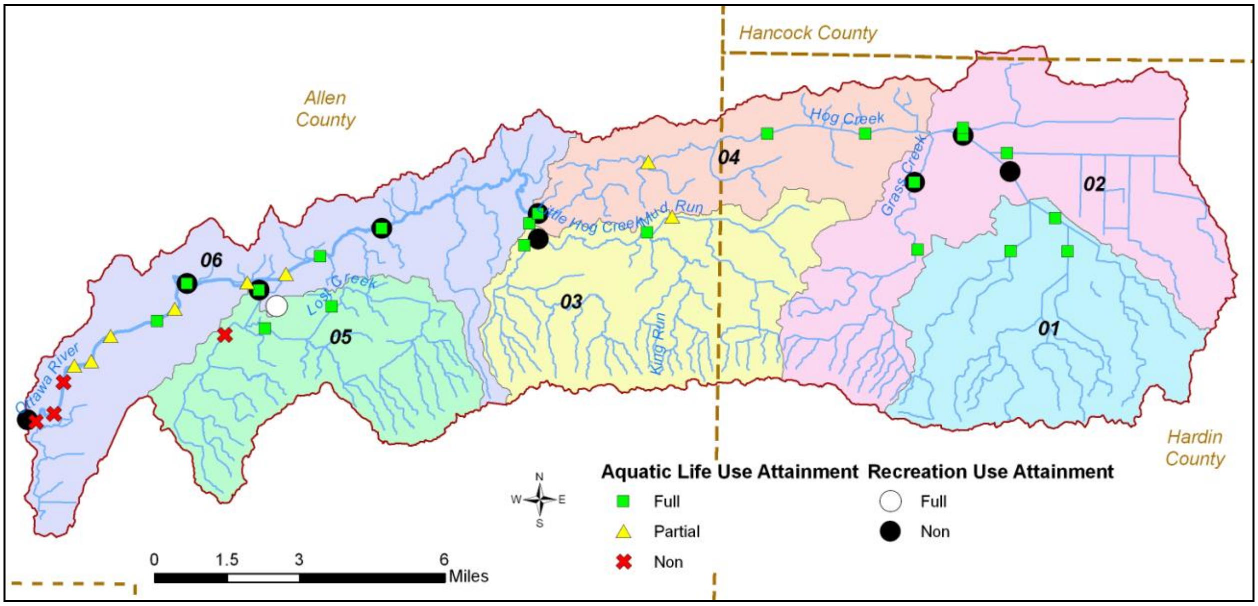


Figure 3-2. Attainment results for the Upper Ottawa River subwatershed.

In most cases, these causes are associated with land uses in the subwatershed (see Appendix C for further information). Figure 3-3 shows land use within the Upper Ottawa River subwatershed.

The land use in this subwatershed speaks directly to the condition and health of the streams. In the headwaters of Hog Creek, agricultural production is only possible because of the network of artificially drained fields. Small streams have been extensively channelized to support the tile and ditch drainage system, which contributes to nutrient and sediment runoff. The lack of riparian shade led to sustained low dissolved oxygen levels in Hog Creek and some headwater tributaries. Failed HSTS and manure from two CAFOs contributed to the recreation use impairment, while two small municipal wastewater treatment plants discharged ammonia and bacteria above water quality standards during the survey.

As Hog Creek flows west and becomes the Ottawa River, land practices change to more rural residences and suburban neighborhoods. This stretch of the river is the public water supply corridor protection zone for the city of Lima. During the 2010 survey the Ottawa River at the Metzger Reservoir intake was found to contain nitrate and atrazine levels that exceeded water quality standards.

Land use changes rapidly from rural to urban and then heavy industrial zones as the river flows west through the city of Lima. It suffers both from water quality and quantity problems because of CSOs and industrial and municipal point source discharges. Even though drinking water is not withdrawn during summer months, the Ottawa River does not have sufficient flow to assimilate the CSOs and large volumes of other wastewater. Low head dams through the city are preventing flow movement, which exacerbates nutrient enrichment and adds to the low dissolved oxygen stress on aquatic life.

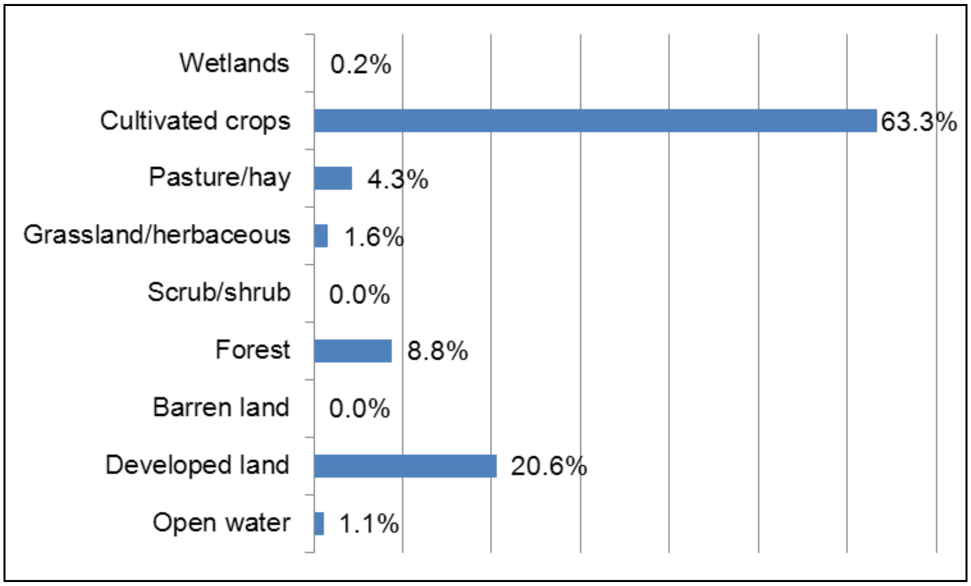


Figure 3-3. Land use in the Upper Ottawa River subwatershed.

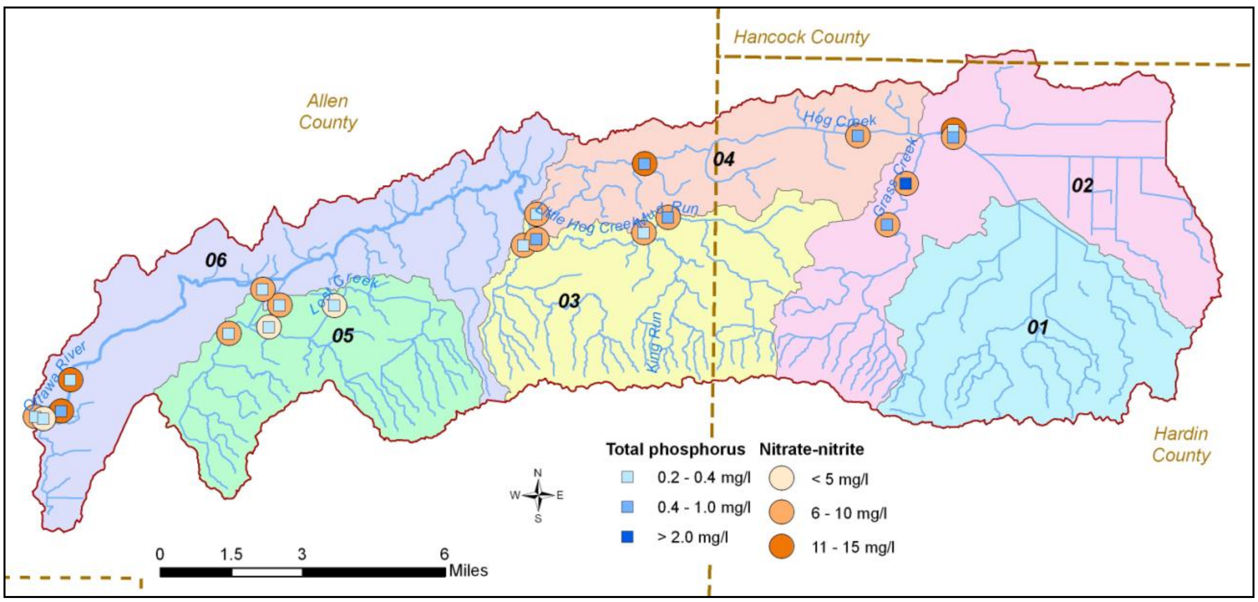


Figure 3-4. Water chemistry results for the Upper Ottawa River subwatershed.

Figure 3-4 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figures 3-5 and 3-6 show relative occurrence of causes and sources, respectively, of aquatic life use impairment in the Upper Ottawa River subwatershed.

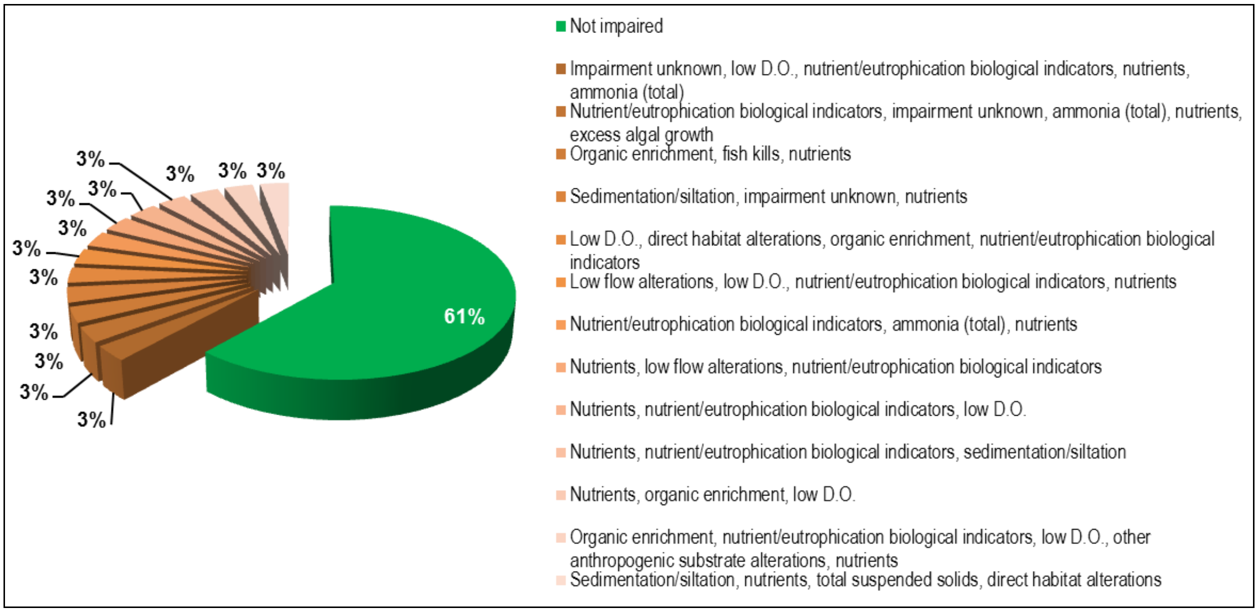


Figure 3-5. Causes of aquatic life use impairment in the Upper Ottawa River subwatershed.

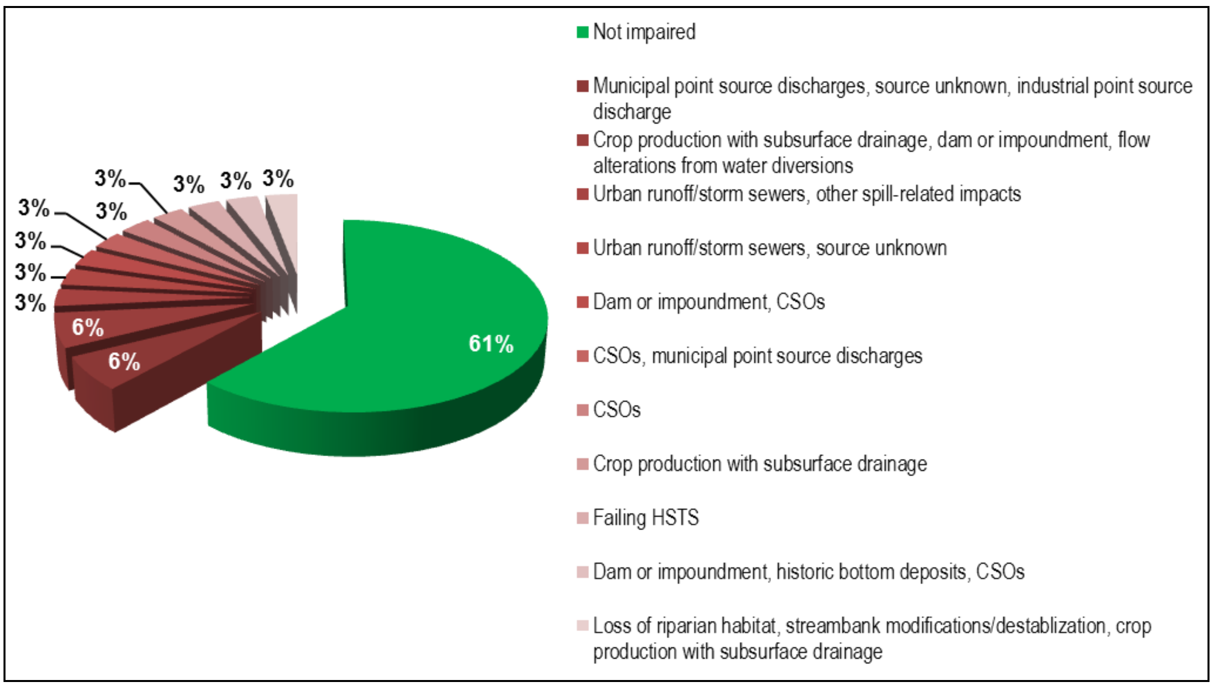


Figure 3-6. Sources of aquatic life use impairment in the Upper Ottawa River subwatershed.

Table 3-1 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-1. Number of impaired sites, organized by use and nested subwatershed, in the Upper Ottawa River subwatershed.

Nested Subwatershed (04100007 03)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use[1]	Human Health Use[1,2]
03 01	# impaired sites (non/partial)	0 / 0	N/A	N/A	5h
	Index score[3]	100	N/A	N/A	N/A
03 02	# impaired sites (non/partial)	0 / 0	3	N/A	5h
	Index score	100	41.7	N/A	N/A
03 03	# impaired sites (non/partial)	0 / 2	1	N/A	5h
	Index score	75	50	N/A	N/A
03 04	# impaired sites (non/partial)	0 / 1	1	N/A	5h
	Index score	75	50	N/A	N/A
03 05	# impaired sites (non/partial)	1 / 0	1	3i	1
	Index score	75	75	N/A	N/A
03 06	# impaired sites (non/partial)	3 / 6	3	3i	5
	Index score	16.7	58.3	N/A	N/A

1 The category from the 2012 Integrated Report is listed rather than number of sites impaired.
2 Impairments to the human health use are not being addressed in this TMDL.
3 The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Hog Creek arises from a network of tributaries draining a 17,000 acre deposit of lake plain clayey till and laminated lacustrine clays in northwestern Hardin County, immediately east and northeast of the village of Ada. This area was once a vast wetland complex known regionally as the Hog Creek marsh. In order to bring this land under cultivation and to otherwise facilitate human habitation, extensive drainage improvements have been made. The entire drainage network (all tributaries) of Hog Creek have been subjected to extensive channelization and other forms of hydromodification, with many streams appearing wholly artificial, being cut into the landscape through human activity to drain the associated marshlands. These modifications were not limited to tributaries, as Hog Creek itself is modified to varying degrees up to the Allen/Hardin county line. Furthermore, the modified areas described above are presently petitioned ditches, and as provided by Ohio law, are maintained for agricultural drainage. Thus, these and other waters so classified will and must serve as outlets and drainage conveyances well into the foreseeable future. As measured by the QHEI, over 80 percent of the stations indicated a level of macrohabitat quality below the WWH benchmark.

Little Hog Creek and its associated tributaries drain ground moraine and to a lesser extent the northern slopes of the Wabash end moraine. Broadly speaking, habitat quality was in the fair range, as indicated by a subbasin average QHEI score of 51.4. QHEI values between 55 and 45 indicate that limiting components of physical habitat are present and may exert a negative influence upon ambient biological performance. However, because of the potential for compensatory stream features (e.g., strong ground water influence) or other watershed variables, QHEI scores within this range do not necessarily exclude WWH. Although by no means optimal, and in many ways naturally limited, macrohabitats through most of the Little Hog Creek catchment appeared capable of supporting a minimal warmwater assemblage of aquatic organisms.

Three small direct Ottawa River tributaries, Lost Creek, Zurmehly Creek and the Little Ottawa River, drain the greater Lima metropolitan area. To varying degrees nearly all of these waters labor under numerous and deleterious effects of a well-drained, urban and suburban landscape that typifies all or most of their respective watersheds. Chief among these effects is a flashy or compressed flow regime, where during periods of wet weather, surface runoff is rapidly delivered to associated streams, resulting in peak flows that are simultaneously greater, but of a shorter duration, than one would expect of a rural or otherwise unmodified counterpart. A hardened watershed, and resulting artificial flow regime, not only disrupts the native fluvial processes responsible for channel formation and maintenance, but also significantly diminishes the surrounding landscape's ability to attenuate precipitation. Instead of being held in the matrix of soil and vegetation and gradually released over time and thus augmenting surface discharge, surplus water is rapidly carried off the landscape and conveyed to associated streams. Given their position within a populated landscape, these waters are also typically channel modified so as to efficiently receive and convey water to their larger receiving stream during periods of high flow.

3.2 Middle Ottawa River (04100007 04)

The Middle Ottawa River subwatershed drains 105.3 square miles in the southwestern portion of the watershed (see Figure 3-7). It consists of 6 nested subwatersheds. The main streams in the Middle Ottawa River subwatershed include Pike Run, Honey Run, Leatherwood Ditch, the Little Ottawa River and the Ottawa River. Major causes of impairment include nutrients, organic enrichment, low dissolved oxygen and direct habitat alterations. Those causes are primarily associated with municipal and industrial point source discharges, crop production with subsurface drainage, sanitary sewer overflows, urban runoff/storm sewers and channelization.

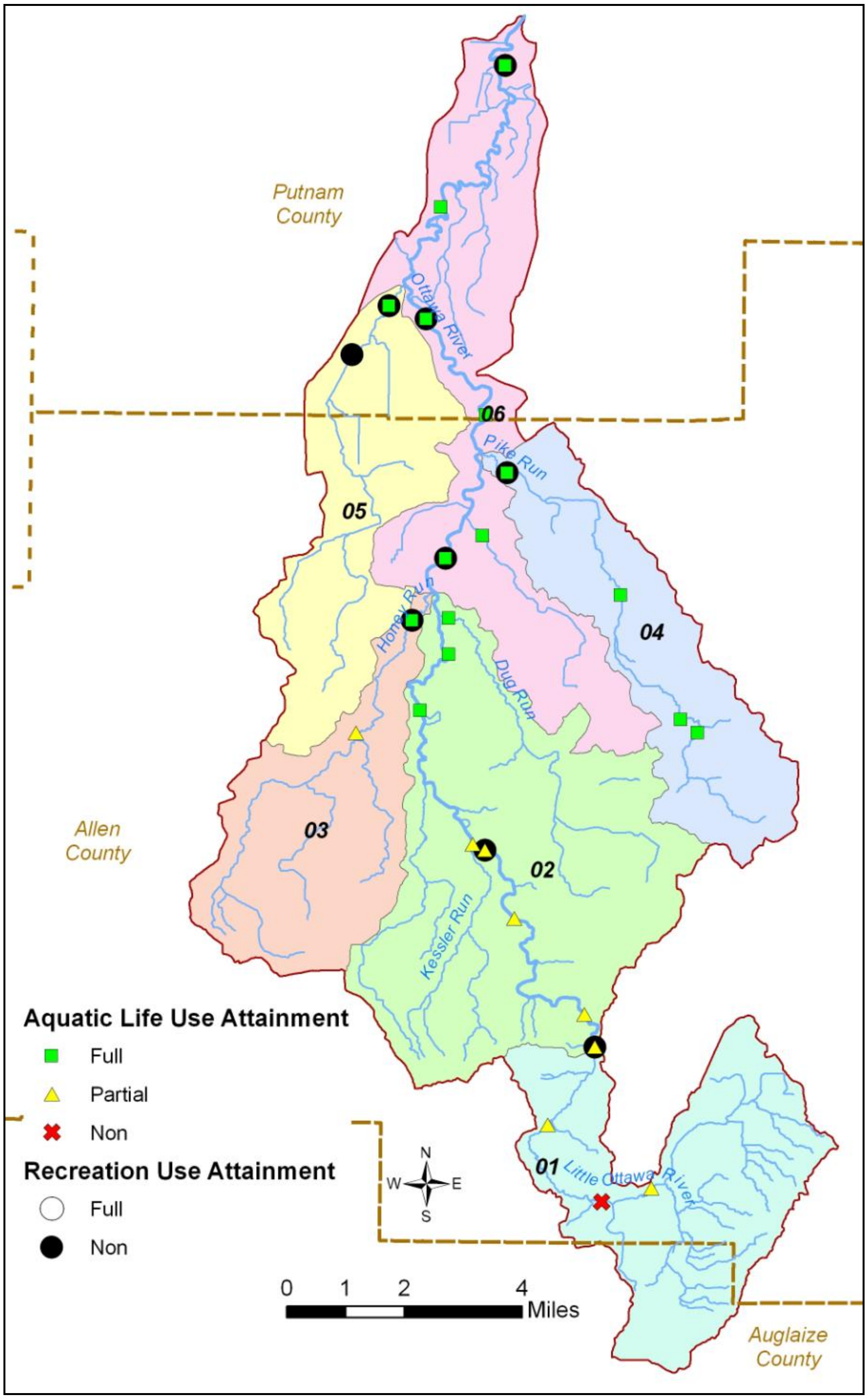


Figure 3-7. Attainment results for the Middle Ottawa River subwatershed.

In most cases, these causes are associated with land uses in the subwatershed (see Appendix C for further information). Figure 3-8 shows land use within the Middle Ottawa River subwatershed.

The mainstem of the Ottawa River leaving Lima carries the signature of industrial and municipal discharges and urban storm water runoff for several miles through the subwatershed. Nutrients, total dissolved solids, ammonia and selenium remained elevated most of the way to Kalida near the mouth of the river, although the number of fish deformities, fin erosions, lesions and tumors (DELT anomalies) has greatly diminished since the 1996 survey. Aquatic life use recovers attainment around Elm Street near Allentown. The Allentown dam, the most downstream impoundment, is a good candidate for removal.

Tributaries in this subwatershed contributed bacteria from a variety of different sources. The Little Ottawa River was impaired by human waste from CSOs and municipal discharges. Honey Creek and Leatherwood Ditch were rural in nature and contributed bacteria from failed HSTS and livestock manure. The mainstem and Pike Run are impacted by small communities that do not have centralized sewage treatment systems. Agricultural nutrients and a lack of riparian shade on some streams that are maintained for agricultural drainage led to widespread low dissolved oxygen levels late in the summer.

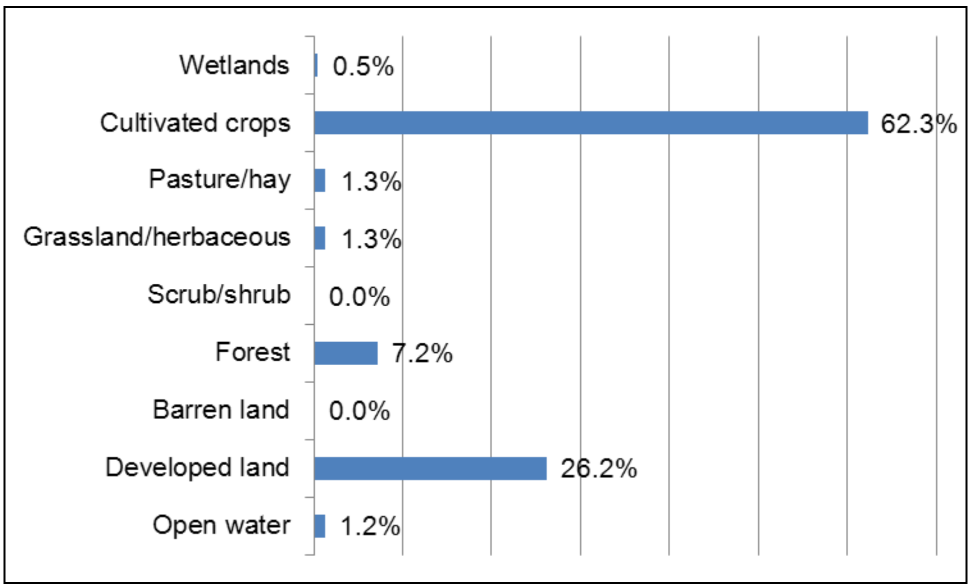


Figure 3-8. Land use in the Middle Ottawa River subwatershed.

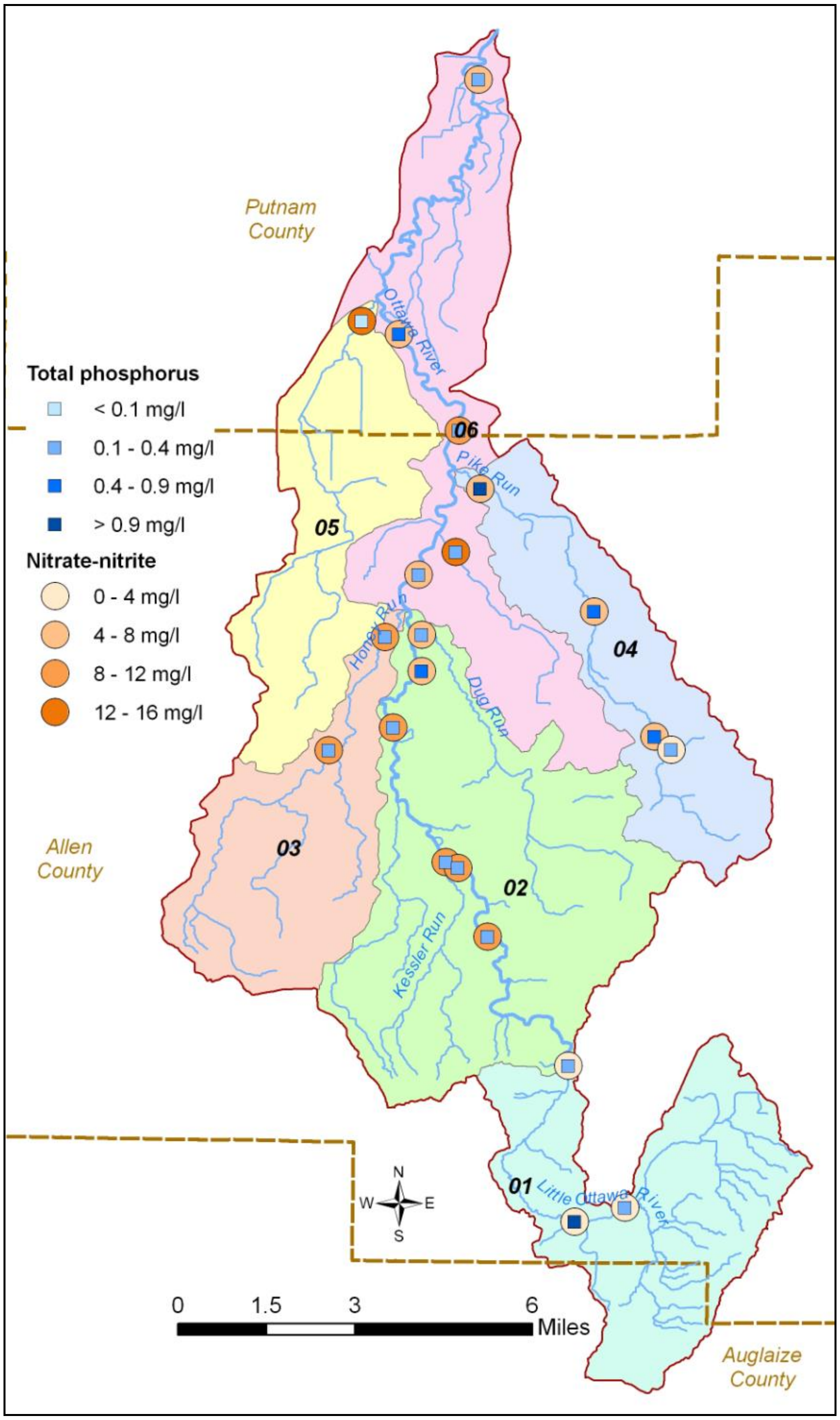


Figure 3-9. Water chemistry results for the Middle Ottawa River subwatershed.

Figure 3-9 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figures 3-10 and 3-11 show relative occurrence of causes and sources, respectively, of aquatic life use impairment in the Middle Ottawa River subwatershed.

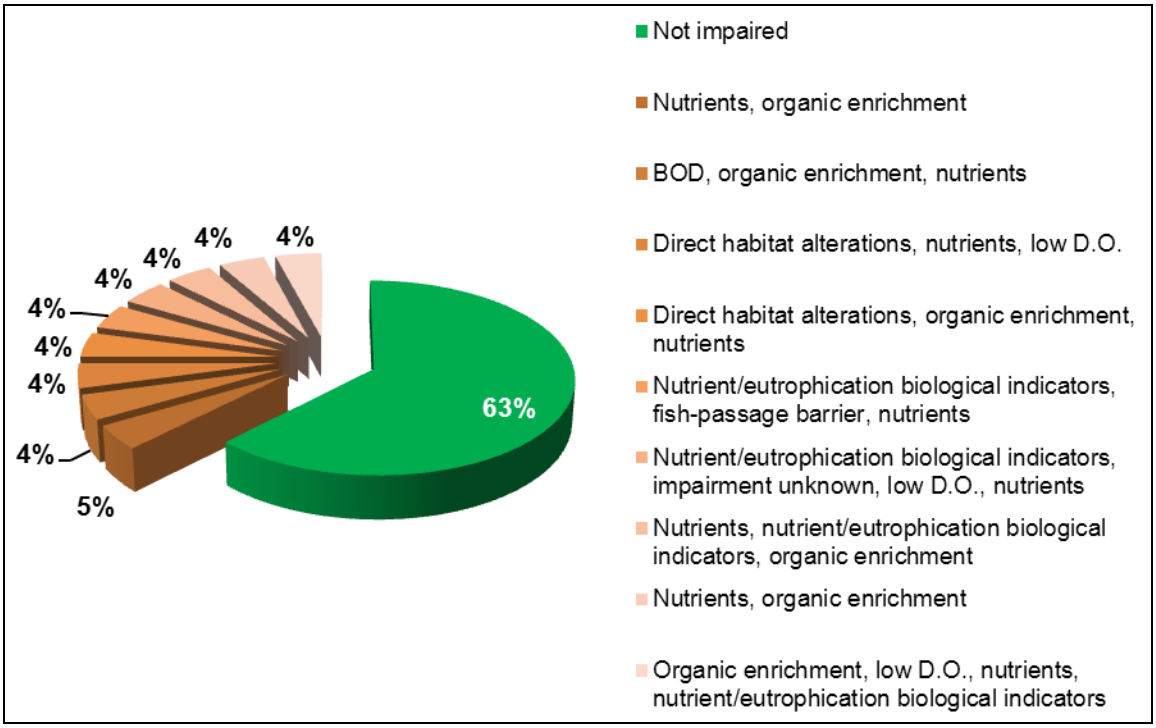


Figure 3-10. Causes of aquatic life use impairment in the Middle Ottawa River subwatershed.

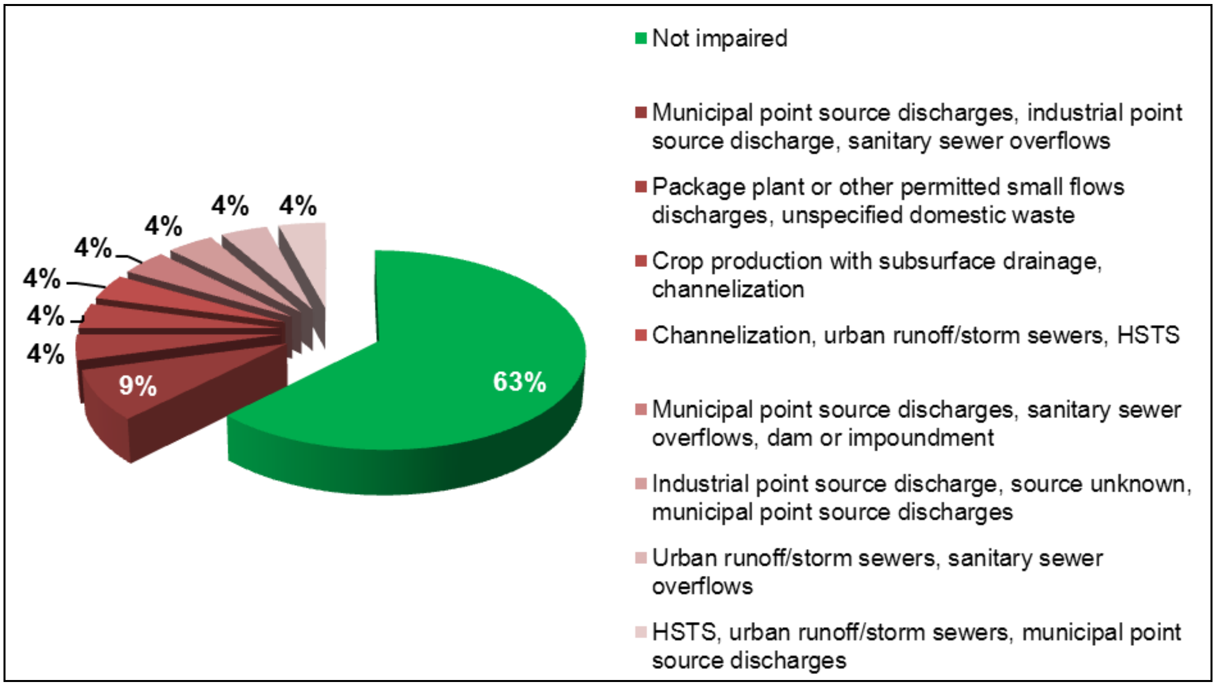


Figure 3-11. Sources of aquatic life use impairment in the Middle Ottawa River subwatershed.

Table 3-2 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-2. Number of impaired sites, organized by use and nested subwatershed, in the Middle Ottawa River subwatershed.

Nested Subwatershed (04100007 04)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use[1]	Human Health Use[1,2]
04 01	# impaired sites (non/partial)	1 / 3	1	N/A	5h
	Index score[3]	0	50	N/A	N/A
04 02	# impaired sites (non/partial)	0 / 4	1	N/A	5h
	Index score	66.7	75	N/A	N/A
04 03	# impaired sites (non/partial)	0 / 1	1	3i	5h
	Index score	50	25	N/A	N/A
04 04	# impaired sites (non/partial)	0 / 0	1	N/A	5h
	Index score	100	0	N/A	N/A
04 05	# impaired sites (non/partial)	0 / 0	2	N/A	5h
	Index score	100	37.5	N/A	N/A
04 06	# impaired sites (non/partial)	0 / 0	2	N/A	5h
	Index score	100	75	N/A	N/A

1 The category from the 2012 Integrated Report is listed rather than number of sites impaired.
2 Impairments to the human health use are not being addressed in this TMDL.
3 The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Major tributaries in this subwatershed include Honey Creek, Dug Run, Beaver Run, Pike Run and Leatherwood Ditch. Taken together, QHEI values as low as 30, and with an average of 46.0, strongly suggest that significant habitat limitations exist throughout these tributaries. All contained ample evidence of past channelization, the degree and extent varying by station or subbasin. Streams so affected were typically trapezoidal in cross section, deeply incised, and monotonous in form. Dominant substrates were typically fines (sand and to a lesser extent pea gravel) with coarser material, if present, often embedded by or with a mix of clayey silts and sand.

3.3 Lower Ottawa River (04100007 05)

The Lower Ottawa River subwatershed drains 124.6 square miles in the northern portion of the watershed (see Figure 3-12). It consists of three nested subwatersheds. The main streams in the Lower Ottawa River subwatershed include Sugar Creek, Plum Creek and the Ottawa River. Major causes of impairment include organic enrichment and nutrients. Those causes are primarily associated with combined sewer overflows and municipal point source discharges.

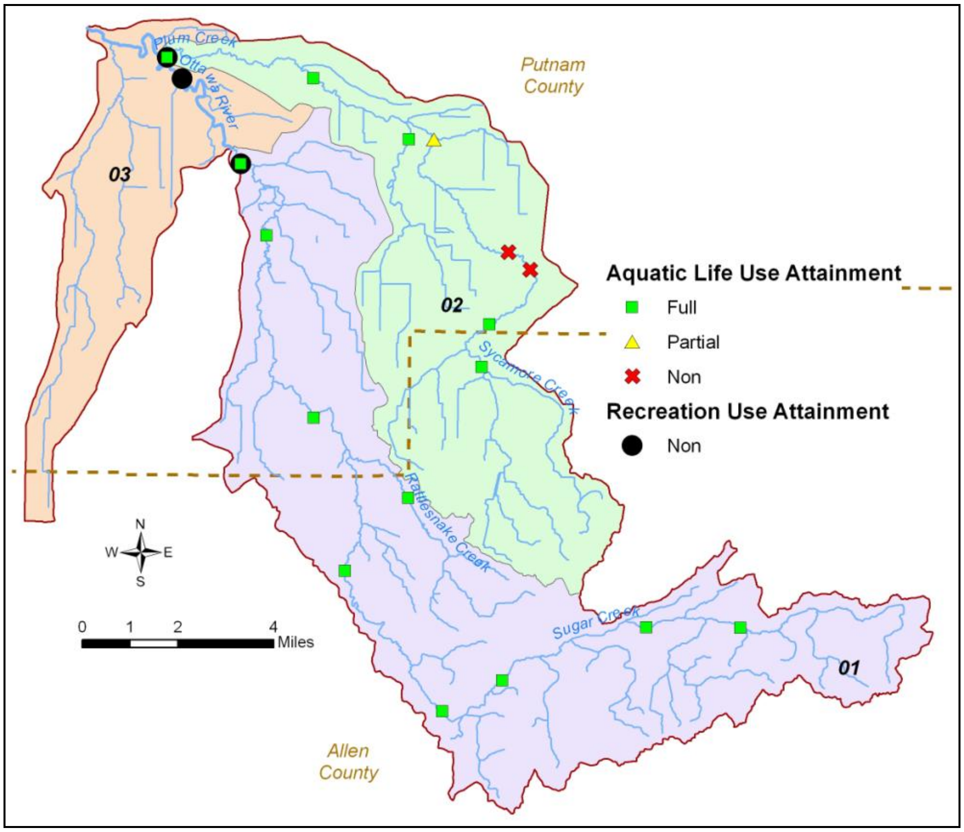


Figure 3-12. Attainment results for the Lower Ottawa River subwatershed.

In most cases, these causes are associated with land uses in the subwatershed (see Appendix C for further information). Figure 3-13 shows land use within the Lower Ottawa River subwatershed.

The Lower Ottawa River subwatershed is predominantly agricultural land and exhibits the typical problems associated with row crop production and tile drainage practices. However, it had the highest level of aquatic life use attainment of the three subwatersheds in this survey. Plum Creek was impaired by a small municipal wastewater discharge and active CSOs.

Sugar Creek exhibited full attainment along most of the stream, but aquatic life could be stressed by excessive nutrient inputs in the upper watershed area. Agricultural nutrients and a lack of riparian shade on streams that are maintained for agricultural drainage did lead to pervasive low dissolved oxygen levels in the warm, dry months of the survey.

As in the other subwatersheds, the Lower Ottawa River was likewise impaired for recreation use by a combination of municipal CSOs, an unsewered community, and failing HSTS.

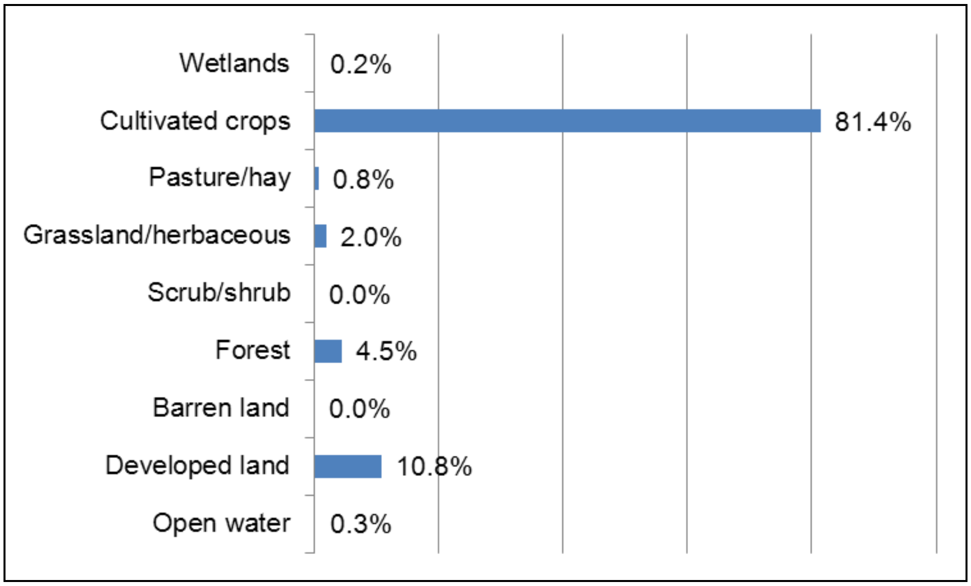


Figure 3-13. Land use in the Lower Ottawa River subwatershed.

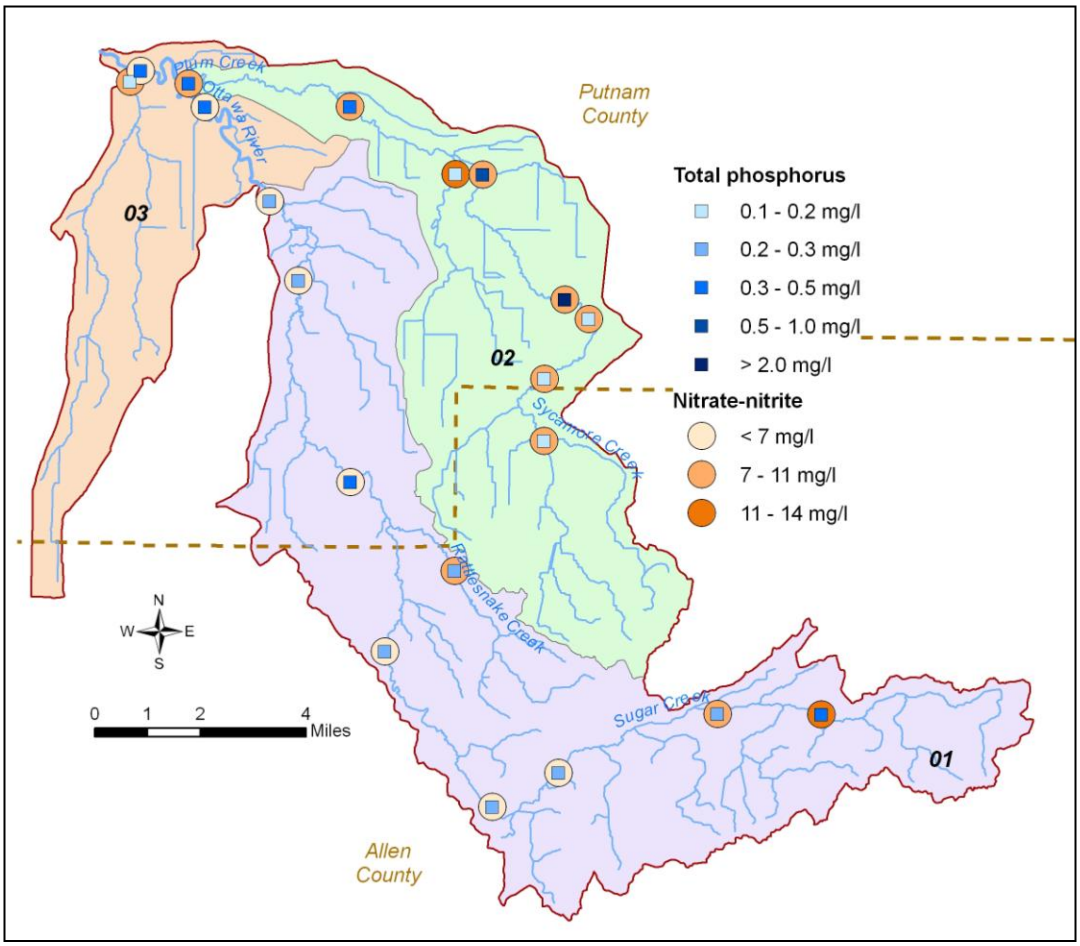


Figure 3-14. Water chemistry results for the Lower Ottawa River subwatershed.

Figure 3-14 shows water chemistry results in the subwatershed. Some of these results aided in identifying causes of aquatic life use impairment. Figures 3-15 and 3-16 show relative occurrence of causes and sources, respectively, of aquatic life use impairment in the Lower Ottawa River subwatershed.

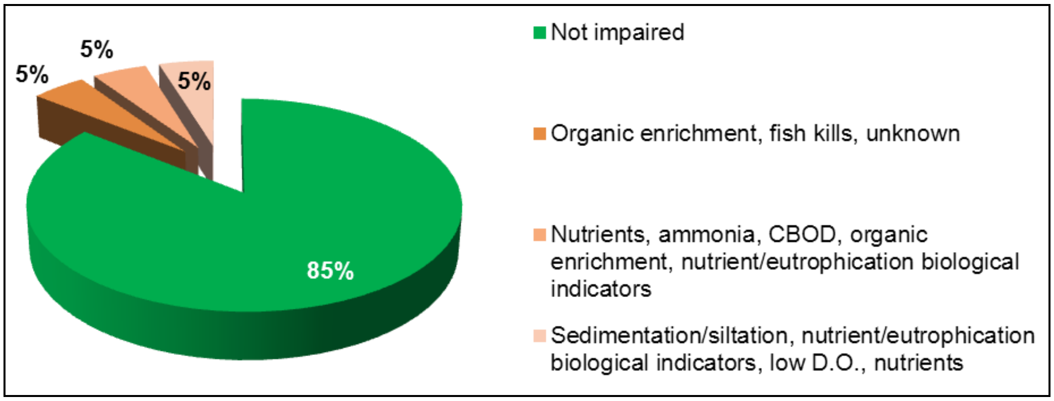


Figure 3-15. Causes of aquatic life use impairment in the Lower Ottawa River subwatershed.

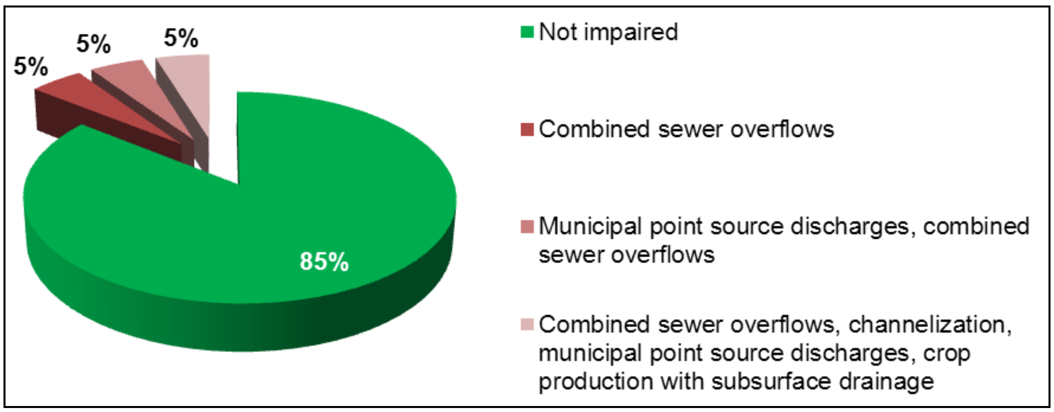


Figure 3-16. Sources of aquatic life use impairment in the Lower Ottawa River subwatershed.

Table 3-3 shows the site-by-site results for each designated beneficial use organized by nested subwatersheds. For more specific information regarding individual site assessment results and supporting chemistry results, please see Appendix B.

Table 3-3. Number of impaired sites, organized by use and nested subwatershed, in the Lower Ottawa River subwatershed.

Nested Subwatershed (04100007 04)		Aquatic Life Use	Recreation Use	Public Drinking Water Supply Use[1]	Human Health Use[1,2]
05 01	# impaired sites (non/partial)	1 / 0	1	N/A	5h
	Index score[3]	93.8	25	N/A	N/A
05 02	# impaired sites (non/partial)	2 / 1	1	N/A	5h
	Index score	63.3	50	N/A	N/A
05 03	# impaired sites (non/partial)	0 / 0	1	N/A	5h
	Index score	100	75	N/A	N/A

[1] The category from the 2012 Integrated Report is listed rather than number of sites impaired.
[2] Impairments to the human health use are not being addressed in this TMDL.
[3] The index score (between 0 and 100) indicates the relative support of the aquatic life or recreation use in the nested subwatershed. A score of 100 indicates full support of the use.

Major tributaries in this subwatershed include Sugar Creek, Plum Creek and Rattlesnake Creek. All of these streams drain primarily rural or otherwise agricultural areas. Because of the natural poor drainage in the area, these tributaries appeared to have been channel modified or otherwise physically manipulated to improve or support local and subregional drainage.

Owing to poor natural drainage throughout much of the catchment, all monitoring stations on Sugar Creek contained ample evidence of direct channel modification or the effects of related hydromodification, the degree and extent varying longitudinally. Although a few stations yielded QHEI scores within the fair to good range, the central tendency of Plum Creek and its associated tributaries reflects habitat limited conditions. Rattlesnake Creek was deeply incised, with limited sinuosity, fine substrates, and moderate to heavy siltation.

3.4 Ottawa River Mainstem

From the confluence of Hog and Little Hog creeks, the whole Ottawa River mainstem was assessed (RM 50.7 to the mouth) at 26 sites in the 2010 survey. Twenty sites were located in the ECBP ecoregion, with the most downstream (northern) six survey sites sampled in the HELP ecoregion. Fourteen of 26 mainstem survey sample sites (54 percent) were attaining the designated WWH aquatic life use performance criterion. Of the non-attaining sample sites, ten (38.5 percent) were in partial attainment and two (7.5 percent) were in non-attainment. The lower 28.8 river miles of the Ottawa River mainstem met the WWH ecoregional biological performance criteria. In all, 46 percent (12 of 26) of Ottawa River mainstem sites segments were impaired. Most were located within Lima or upstream near impoundments used for current or past public water withdrawal. For specific information about site attainment, please see Appendix B.

A leading associated cause and source of the aquatic life use impairments in the rural Ottawa River tributaries and upper Ottawa River upstream reaches in the basin was nutrient enrichment / eutrophication from nonpoint source (NPS) nutrient inputs (through tile discharges to modified tributaries or surface runoff). These impairments occurred in the upper Ottawa River mainstem and rural reaches of other Ottawa River basin tributaries. Many of the modified streams expedite nutrient delivery downstream where enrichment and excess algal production caused diel high and low D.O. fluctuations (and sometimes high pH values) exacerbated by low flow conditions. Tributaries in urban areas (Little Ottawa River, an unnamed tributary to Lost Creek in Lima and Plum Creek near or downstream from Columbus Grove) had larger issues with organic enrichment from sewers (sanitary sewer overflows, or SSOs) or episodic plant events (CSOs).

The main causes of impairment in urban Lima were nutrient enrichment and organic enrichment, with subsequent low dissolved oxygen from urban SSO/CSO inputs, and municipal and industrial discharges exacerbated by low flows from flow alteration (impoundments) and water withdrawals. Effects in urban Lima would be worse if not for daily intermittent quarry flows augmenting summer low flows. Through urban Lima, a series of five dam pools with five major CSO discharges are contained within a three mile reach. All are in close proximity to one another and can form contiguous impoundments. During this and previous Ohio EPA surveys, these relief points in Lima's collection system have been significant sources of pollutant loads and have directly contributed to aquatic life use impairment (Ohio EPA 1992, 1998).

Upon exiting downtown Lima, the Ottawa River receives treated effluent from three major NPDES permitted entities in a distance of just over one river mile: Lima WWTP (a municipal treatment works), Lima Refining Co. (also known as Husky Oil), and PCS Nitrogen (an industrial supplier of nitrogenous products). Any limitations or other water quality issues related to diminished stream flow are abruptly abated downstream from the Lima WWTP, as the discharge of the Ottawa River is significantly augmented by this 18.5 million-gallon-per-day facility. Fair quality conditions continued, as all three sites downstream from these dischargers failed to support WWH biological communities with different stressors at and among the sites.

The condition of the fish assemblage downstream from the Lima Refining Co. at RM 37.0 was markedly diminished with a reduced IBI and MIwb well below the WWH standard. The number of sensitive fish species significantly decreased, the incidence of deformities, eroded fins, lesions and tumors (DELT) anomalies rose sharply, and overall fish community structure declined. Similar fair quality fish community conditions were found downstream from PCS Nitrogen, at RM 36.1, and at the next downstream station at RM 34.6. Observed signature toxic responses continued among the macroinvertebrate community, with the highest percentage of tolerant taxa documented from the Erie Railroad impoundment (RM 38.6) to downstream from each major discharger (RM 36.0) (Yoder and Rankin 1995).

Below the Allentown dam, the lower 28.8 river miles of the Ottawa River mainstem met the WWH ecoregional biological performance criteria for the fish and macroinvertebrate communities in 2010. The strong performance of the ICI, MIwb and the absence of poor IBI scores on the Ottawa River indicate that pollution abatement efforts to date have yielded meaningful improvements, leaving little doubt that the Ottawa River mainstem has entered a phase of strong environmental recovery.

3.4.1 Habitat

As measured by the QHEI, the quality of near and in-stream macrohabitat throughout most of the Ottawa River appeared capable of supporting diverse, functionally organized, and well-structured assemblages of aquatic organisms consistent with biological goals. Most sites contained a complement of positive channel, substrate, and riparian features, minimally compatible with the river's WWH aquatic life use designation. However, conditions were not uniform, as the Ottawa River mainstem consists of a patchwork of high to moderate quality free-flowing reaches, found largely within the southern rural portions of the watershed, and lower quality channel modified and/or impounded segments within the northern rural portions of the watershed and the urban and suburban environs of greater Lima.

Evidenced by a low ratio of modified/warmwater macrohabitat attributes and QHEI scores ranging between 70.0 and 81.0, the river appeared in a relatively natural or unmodified state upstream from Lima at both the Thayer Rd. and Fetter Rd. stations. However, macrohabitat quality and resulting QHEI scores fell sharply as the Ottawa River entered the greater Lima area. QHEI scores in Lima were reflective of historic channel modification, impoundment, and to a lesser extent sedimentation.

3.4.2 Trends

Multiple data sets were available to assess ambient biological performance in the Ottawa River watershed through time. In one form or another, the Ottawa River has been regularly assessed by Ohio EPA since the early 1970s. Prior Ohio EPA field work has included all or portions of the mainstem and selected tributaries, supporting various water quality management goals (e.g., NPDES, stream regionalization, use attainability analysis and reference site monitoring). The first significant attempt to evaluate the entire basin was undertaken in 1996, where the majority of the mainstem and major tributaries were systematically sampled (Ohio EPA 1998). Earlier

Ohio EPA field efforts, both large and small, were undertaken in 1974, 1976, 1977, 1985, 1989, 1990, 1991, and 1995.

The maximum area negatively influenced by the Ottawa River in the first half of the twentieth century extended downstream through the Auglaize River to include a portion of the Maumee River. Through early pollution abatement efforts, by the mid-1970s, impacts had contracted significantly to include only the Ottawa River, with an incipient recovery evident near the mouth (Ohio EPA 1979). However, water quality through the historically degraded reach downstream from Lima remained extremely poor, as the cumulative pollutant load continued to exceed the river's assimilative capacity. Specifically, biological impacts paralleled water quality standards violations for dissolved oxygen, ammonia, chromium, phenols, and surfactants, which were numerous and regularly observed downstream from all the major facilities near Lima. Localized toxicity associated with private dischargers and the Lima WWTP was also identified, as well as the deleterious effects of pollutant loads derived from Lima's CSOs and SSOs (Ohio EPA 1979). Improved waste treatment and stricter enforcement attending additional amendments to the Federal Water Pollution Control Act (i.e., the Clean Water Act) resulted in additional water quality improvements and associated biological recovery through the 1980s and into the early 1990s, particularly when compared to the gross pollution identified in the previous decades. Despite the significant improvements achieved during this period of time, substantial pollution problems persisted through and downstream from Lima (U.S. EPA 1984; Ohio EPA 1992).

Biological communities showed a trend of significant recovery in 2010. However, these data results also clearly delineated impacted areas (and corresponding recovery through time) relative to major pollution sources, stressors or limiting factors on the Ottawa River. Prior to 2010, historical surveys portrayed significant and unambiguous depressions in community performance (indices and other biometrics) both through and downstream from Lima, with a secondary depression evident well downstream from Lima, beginning in the vicinity of Elida and extending to Kalida. Persistent local departures from the associated biocriteria and diminutions of other biometrics were documented immediately upstream from Lima as well.

By 2010, 37.5 miles (74 percent) of the 50.7 linear stream miles of the mainstem were found to support the appropriate biological assemblage (fish and macroinvertebrates) at least minimally consistent with WWH biocriteria. The remaining 13.2 (26 percent) miles failed to support WWH assemblages. However, the magnitude of the departure or degree of impact was not great, as poor to very poor community performance was not observed. Figure 3-17 illustrates the biological improvements over time (from 1985 – 2010, including the 1991 and 1996 surveys).

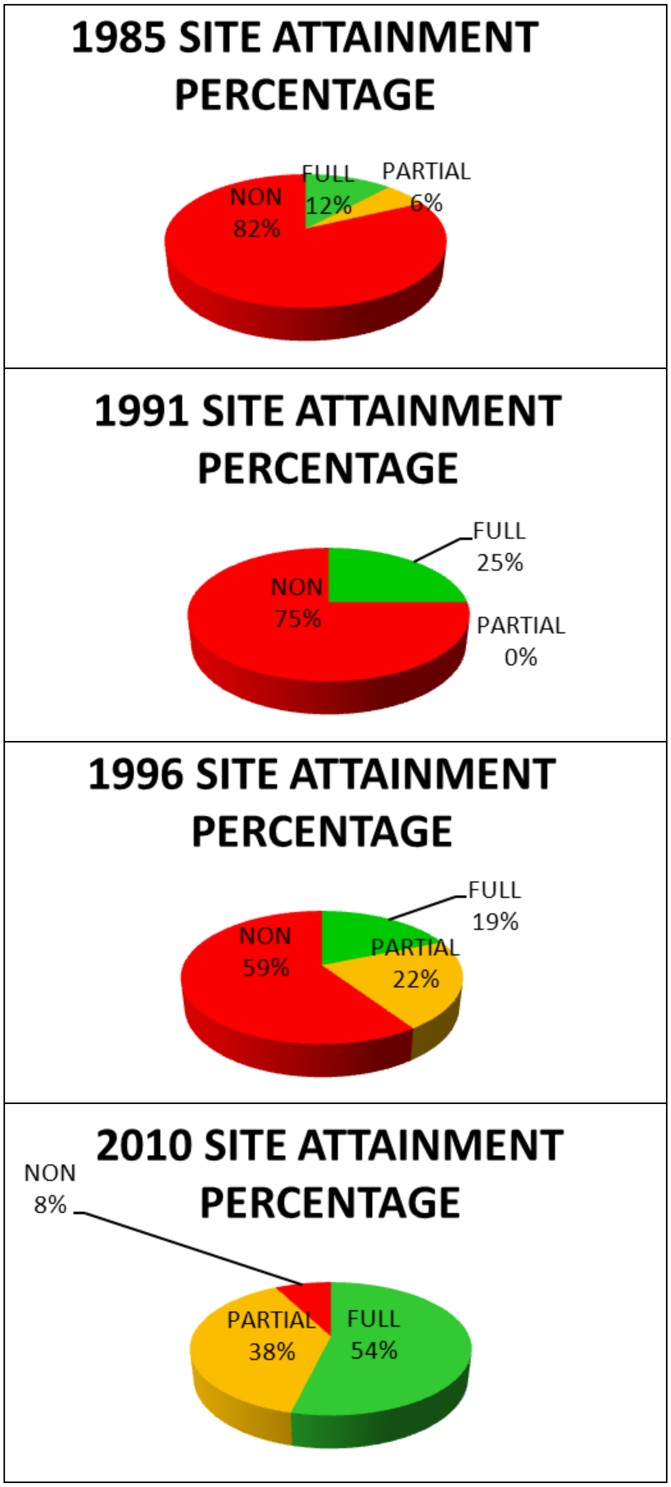


Figure 3-17. Site attainment percentage trends for the Ottawa River mainstem during 1985, 1991, 1996 and 2010 surveys.

4 METHODS TO CALCULATE LOAD REDUCTIONS

The Ottawa River (Lima area) watershed TMDL does not support two beneficial uses—aquatic life and recreation uses. The causes of impairment to aquatic life uses consist of dissolved oxygen (minima and ranges), nutrients, organic enrichment, total suspended solids, sedimentation/siltation, direct habitat alterations, nutrient/eutrophication biological indicators, fish kills, excess algal growth, low flow alterations, total ammonia, other anthropogenic substrate alterations, unknown, biochemical oxygen demand, fish-passage barrier and carbonaceous biochemical oxygen demand. The cause of recreation use impairment is excessive concentrations of an indicator bacterium, *E. coli*. The linkage analysis examines the cause and effect relationships between watershed characteristics and pollutant sources and the effect on the stream biology and evaluates the use of surrogate measures to address the pollutant sources that would result in supporting beneficial uses.

Dissolved Oxygen

The purpose of this linkage discussion is to link the cause of impairment to aquatic life (dissolved oxygen) to the sources that trigger the impairment. Dissolved oxygen (DO) is a dynamic parameter of water chemistry that directly affects the survival of aquatic life. Identifying DO as a dynamic parameter acknowledges that it is affected by multiple components of the ecosystem including: temperature, re-aeration, nutrient enrichment, and oxidation of organic matter. Ottawa River watershed assessment sites were noted as having DO violations (OAC 3745-1-07). In the Ottawa River watershed two cases are identified that contribute to DO violations: nutrient enrichment/eutrophication *and* organic enrichment (sewage).

Nutrient Enrichment and Nutrient Eutrophication

Nutrients rarely approach concentrations in the ambient environment that are toxic to aquatic life, and are essential to the functioning of healthy aquatic ecosystems at appropriate concentrations. However, nutrient concentrations in excess of the needs of a balanced ecosystem (nutrient enrichment) can exert negative effects by causing excess primary production (Sharpley *et al.* 1999). The excess primary production causes negative effects including large diel fluctuations of DO and potential for minimum DO violations when respiration and decomposition of dead algae (eutrophication) is high. Such changes shift fish species composition away from functional assemblages comprised of intolerant species, benthic insectivores and top carnivores typical of high quality streams towards less desirable assemblages of tolerant species, niche generalists, omnivores and detritivores typical of degraded streams (Ohio EPA 1999). Such a shift in community structure lowers the diversity of the system; the IBI and ICI scores reflect this shift and a stream may be precluded from achieving its aquatic life use designation.

Phosphorus is selected as the focal point for nutrient TMDLs because it is typically the limiting nutrient to algal growth in the fresh water systems (Mcdowell *et al*. 2009). Therefore, by limiting the loading of phosphorus to streams, the impacts caused by nutrient enrichment will be mitigated. Ohio EPA developed statewide total phosphorus (TP) targets for streams on the basis of basin size in order to address nutrient enrichment impacting aquatic life (Ohio EPA 1999). Ohio EPA has implemented phosphorus limitation in other watersheds and clearly documented how reducing TP loadings to streams mitigates in-stream nutrient enrichment (Ohio EPA 2007). All impaired streams receive a TMDL for total phosphorus. In some cases the TMDL is based on a specified critical condition where certain sources are not mentioned. An example is the TMDL for the mainstem of the Ottawa River that does not result in allocations for the industrial storm water discharges and CSOs. The selected critical condition is such that these sources do not directly contribute a nutrient load during the low flow condition.

Organic Enrichment

The other case of loading that causes DO violations is organic enrichment from external sources. The result is conditions similar to eutrophication where DO is depressed by the oxidation of organic matter. The difference between the two causes is the source of the organic matter: in-stream production vs. external loading. In the case of the Ottawa River, biological indicators for organic enrichment are listed as a cause of impairment when linked to external sources of organic matter. The presence of certain sources is common where impairments are indicated including: Combined Sewer Overflows (CSOs), Sanitary Sewer Overflows (SSOs), and non-point sources (includes failing on-lot home sewage treatment systems (HSTS)). Other sources contribute to external organic loading exist including industrial storm water permits and continuous point source discharges (includes HSTS with NPDES permit); however these are ubiquitous to the watershed (not limited to occurring in impaired areas) and are not indicated as a source stimulating organic enrichment. In one case a TMDL is computed directly to address organic enrichment but in most instances surrogate TMDLs for a different pollutant address the reduction necessary to account for organic enrichment. As some of the sources of organic load are not attributed to organic enrichment they are not accounted for with an allocation in a TMDL.

Four tributaries (Little Hog Creek, Lost Creek, Little Ottawa River and Plum Creek) and two Ottawa River mainstem areas have impairment partially attributed to organic enrichment. In the case of the tributaries surrogate TMDLs for phosphorus represent the reduction needed in the sources causing enrichment. The tributaries are associated with enrichment from CSOs, SSOs, and on-lot HSTS. Nutrient enrichment is also indicated in each of these watersheds and the impairment is addressed with a TMDL for total phosphorus. SSOs are prohibited and thus receive no wasteload; in phosphorus TMDLs they are not included thus indicating no wasteload is allocated for SSOs. The only way to achieve zero load is to eliminate the discharge. Tributary CSOs only occur in one instance for the village of Columbus Grove and Plum Creek. Columbus Grove is on a schedule to separate the sewer system and as such for the purposes of the TMDL the CSOs are given zero load for the surrogate parameter phosphorus. On-lot HSTS (occurring in all impaired tributaries) are part of the non-point source load but by definition are meant to treat and assimilate all pollutants on the site. Systems commonly fail with an Ohio Department of Health survey from 2012 (ODH 2013) survey indicating that some 31 percent of the systems statewide are failing. As a convention these systems are considered to contribute no load to the streams but load is reserved in the form of an allowance for future growth in the case that correction of a failing system requires issuing an NPDES permit. The attribution of no load to these systems is again accounted for with the zero allocation for phosphorus. The source of impairment for mainstem sites is attributed to loads from the city of Lima CSOs. This source is dealt with explicitly with a TMDL for $CBOD_5$ in a specified critical condition. A summary of where organic enrichment occurs and how the sources are addressed is presented in Table 4-1.

Table 4-1. Summary of organic enrichment sources and how the source is covered by a TMDL.

Nested Subwatershed (04100007)	CSOs	SSOs	HSTS
03 03	NP	NP	PZ
03 05	NP	NP	PZ
03 06	**PA**	PZ	PZ
04 01	**PA**	PZ	PZ
04 02	**PA**	PZ	PZ
05 02	PZ	PZ	PZ

NP - Not present as a source of impairment
PA - Present - receives WLA
PZ - Present - load is zero

Habitat Alteration and Sedimentation/Siltation

Habitat alteration and sedimentation are both common causes of impairment in the Ottawa River watershed. Poor habitat quality and an excessive amount of stream bed deposited sediment are environmental conditions, rather than a pollutant loads, so development of a load-based TMDL to address this cause of impairment is not possible.

The Qualitative Habitat Evaluation Index (QHEI) is a quantitative expression of a qualitative, visual assessment of habitat in free flowing streams and was developed by the Ohio EPA to assess available habitat for fish communities (Ohio EPA 1989a; Rankin 1995). This tool provides a numeric value, which is assigned to a particular stream segment based on the quality of its habitat. The QHEI evaluates six general aspects of physical habitat that include channel substrate, in-stream cover, riparian characteristics, channel condition, pool/riffle quality, gradient and drainage area. Analysis of QHEI and biological response data by Ohio EPA (1999) determined the most sensitive aspects and breakpoint values for these aspects. Using these aspects/breakpoints as targets to directly address habitat impairment as a TMDL is an explicit method to mitigate impairment. This has been successfully employed by Ohio EPA.

Pathogens (Bacteria) Recreation Use Impairments

Elevated bacteria loading is the cause of recreation use impairment in the Ottawa River watershed. The proportion of pathogenic organisms present in assessed waters is generally small compared to non-pathogenic organisms. For this reason most pathogenic organisms are difficult to isolate and identify. Additionally, pathogenic organisms are highly varied in their characteristics and type which also makes them difficult to measure. Nonpathogenic bacteria that are associated with pathogens transmitted by fecal contamination are more abundant and are, therefore, monitored as surrogates because of the greater ease in sampling and measuring. These bacteria are called indicator organisms. Ohio has promulgated water quality standards for the geometric mean concentration for *E. coli* bacteria (OAC 3745-1-07). These values serve as the targets used in the development of the TMDLs that address recreation use impairments. Therefore *E. coli* is used to address recreation use impairment.

Tables 4-2 and 4-3 indicate how the applicable causes of impairment are addressed in each of the assessment units.

Table 4-2. Summary of causes of impairment and actions taken to address them in assessment units within the Upper Ottawa River (04100007 03) ten-digit hydrologic unit.

	Watershed Assessment Units					
	04100007 03					
Causes of Impairment	**01**	**02**	**03**	**04**	**05**	**06**
Aquatic Life Use						
Dissolved oxygen			S			S
Nutrients			D	D	D	D
Organic enrichment (sewage) biological indicators			S		S	D
Total suspended solids			S			
Sedimentation/siltation			D	D		D
Direct habitat alterations			D			D
Nutrient/eutrophication biological indicators				D		D
Fish kills					N	
Excess algal growth						S
Low flow alterations						S
Ammonia (total)						N
Other anthropogenic substrate alterations						S
Unknown						N
Recreation Use						
E. coli		D	D	D	D	

D – direct	Means that TMDLs are calculated for this parameter
S – surrogate	Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause. There is substantial overlap in the sources of the loading of both parameters
N – not addressed	Means that the impairment is not addressed in this report.
Blank	Indicates that the assessment unit is not impaired for this cause.
4B	Means that the 4B option is being used to address impairment.

Table 4-3. Summary of causes of impairment and actions taken to address them in assessment units within the Middle Ottawa River (04100007 04) and Lower Ottawa River (04100007 05) ten-digit hydrologic units.

	Watershed Assessment Units								
	04100007 04						04100007 05		
Causes of Impairment	**01**	**02**	**03**	**04**	**05**	**06**	**01**	**02**	**03**
Aquatic Life Use									
Biochemical oxygen demand	S							S	
Nutrients	D	D	D						
Organic enrichment (sewage) biological indicators	S	D						D	
Direct habitat alterations	D		D						
Dissolved oxygen		S	S					S	
Nutrient/eutrophication biological indicators		D						D	
Fish-passage barrier		N							
Unknown		N						N	
Ammonia (total)								S	

Causes of Impairment	**Watershed Assessment Units**								
	04100007 04						**04100007 05**		
	01	**02**	**03**	**04**	**05**	**06**	**01**	**02**	**03**
Sedimentation/siltation								D	
Fish kills								N	
Recreation Use									
E. coli	D	D	D	D	D	D	D	D	D

D – direct	Means that TMDLs are calculated for this parameter
S – surrogate	Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause. There is substantial overlap in the sources of the loading of both parameters
N – not addressed	Means that the impairment is not addressed in this report.
Blank	Indicates that the assessment unit is not impaired for this cause.
4B	Means that the 4B option is being used to address impairment.

Further details on modeling methods and analyses are available in Appendix D.

Two total phosphorus loading analyses were used to address a variety of issues, including dissolved oxygen, nutrients, nutrient/eutrophication biological indicators and organic enrichment (sewage) biological indicators. Sections 4.1 and 4.2 describe the methods used for total phosphorus TMDLs.

4.1 Load Duration Curves for Total Phosphorus

To create LDCs for the development of TMDLs, the flow duration for each TMDL site is determined. This involves calculating the flow expected for the full range of exceedance percentile. Exceedance percentile stream flows are the probability that a given flow magnitude is exceeded. This normalizes the flows to a range of natural occurrences from extremely high flows (0% exceedance percentile) to extremely low flows (100% exceedance percentile). The flow curve is converted into a load duration curve by taking the product of the flow, the water quality target (0.1 mg/l for WWH) and a conversion factor. The load in kilograms per day is the TMDL for each flow condition. The resulting points are plotted to create a LDC. The water quality samples for each impaired site are converted into loads by taking the product of the total phosphorus concentration, the flow at the time the sample was collected and a conversion factor. Each calculated load is plotted as a point on the LDC plot and compared to the water quality TMDL load. Points that plot above the LDC represent deviations from the water quality standard and the daily allowable load. Points that plot below the curve represent samples in compliance with standards and the daily allowable load.

Water quality samples on the LDC curves are noted as diamonds. Samples taken when storm flow is greater than 50 percent of the flow are noted with the diamond with a red dot in the center (noted as “>50% SF” in the figures legend). This flow condition is determined using the sliding-interval method for streamflow hydrograph separation contained in the USGS HYSEP program (Sloto and Crouse 1996).

Box plots are shown for each flow regime with observed data. The center line of these boxes represents the median TP load for that flow regime. The top and bottom of the boxes represents the 75th and 25th percentiles respectively. The upper and lower vertical bar tails are the maximum and minimum observed loads respectively.

The load duration curves are grouped into five flow regimes noted with vertical lines and labels. These regimes are defined as the following:

High flow zone:	Stream flows in the 0 to 5 exceedance percentile range; these are related to flood flows.
Wet weather zone:	Flows in the 5 to 40 exceedance percentile range; these are flows in wet weather conditions.
Normal range zone:	Flows in the 40 to 80 exceedance percentile range; these are the median streamflow conditions.
Dry weather zone:	Flows in the 80 to 95 exceedance percentile range; these are related to dry weather flows.
Low flow zone:	Flows in the 95 to 100 exceedance percentile range; related to drought conditions.

All of the area beneath the TMDL curve is considered the total phosphorus loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards/targets. The final step to create an LDC is to determine where reductions need to occur. The likelihood of a source affecting the stream varies by flow regime and likely sources in the five flow regimes are indicated in Table 4-4.

Table 4-4. Load duration curve flow zones and typical contributing sources.

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Point source				M	H
Livestock direct access to streams				M	H
Home sewage treatment systems	M	M-H	H	H	H
Riparian areas		H	H	M	
Storm water: Impervious		H	H	H	
Combined sewer overflow (CSO)	H				
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

H = high influence; M = moderate influence; L = low influence

4.1.1 Justification

Nutrients can be modeled explicitly in a detailed manner such as in the model QUAL2K, also used in this report. However, use of a model with this complexity is time consuming and for adequate calibration, more data is needed than what is collected in a routine field survey. In many cases where there are none or few permitted dischargers it in not feasible to collect the additional data to allow for the development of more complex models.

An empirical method of determining TMDL nutrient loading and reductions is utilized with load duration curves (LDCs). This method is appropriate since nutrient sources in Ohio streams can be differentiated by streamflow regime. The main advantage of the use of LDCs is in this method's ability to differentiate loads based on flow regime. The main shortcoming of this method is its lack of being able to differentiate various loads that may occur in the same flow regime (such as cows in stream and poorly operating home sewage treatment systems during periods of low flow). However in smaller tributaries, sources and how their contributions differ between flow regimes are fairly straight forward. In-stream processes and interactions between sources are simplified at this scale mitigating the primary weakness of the technique.

4.1.2 Sources of Data

Most sites with LDCs developed to be TMDLs are at what Ohio EPA refers to as sentinel sites. These sites are picked to represent nested subwatersheds and/or important drainage areas. The sites are sampled more frequently than the other survey sites. Water stage to stream discharge rating curve relationships are also created for each sentinel site. Knowing the stream discharge at each sampling of these sites allows for load calculations to be made without relying on the extrapolations to stream gages. Some additional non-sentinel sites are also utilized to create LDCs for TMDLs. These assessment sites were found to be impaired by nutrient enrichment, but do not have a sentinel site representing them. Table 4-5 shows the sentinel and non-sentinel sites and their drainage area. In order to determine each LDC's flow interval, stream flows are extrapolated to a USGS gage (station # 04187100 Ottawa River at Lima, OH). A drainage area ratio of the LDC site's watershed to the USGS gage's is then applied to the gage flows.

Table 4-5. LDC total phosphorus TMDL sites and their drainage areas.

Nested Subwatershed	Stream Name	Class	Location	River Mile	Drainage Area (Sq. mi.)
04100007 03 04	Hog Creek	WWH	Swaney Rd	0.27	73.7
04100007 03 03	Mud Run	WWH	Bluffton-Bentley Rd	0.65	6.7
04100007 03 03	Little Hog Creek	WWH	Peevee Rd	3.62	12.1
04100007 03 05	Lost Creek	WWH	East High Street	0.35	5.8
04100007 03 06	Zurmehly	WWH	Ft Amanda Road	0.03	3.3
04100007 04 01	Little Ottawa	WWH	Ft Amanda Road	0.03	16.4
04100007 04 03	Honey Run	WWH	Cremeans Rd	3.58	10.9
04100007 05 02	Plum Creek	WWH	TR-O	8.12	22.0

4.1.3 Target(s)

Phosphorus is considered to control the degree of enrichment and as a result targets discussed in this section are for phosphorus. Ohio Administrative Code (OAC) includes narrative criteria that limit the quantity of nutrients that may enter state waters. Specifically, OAC Rule 3745-1-04(E) states that all waters of the state, "…shall be free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae." In addition, OAC Rule 3745-1-04(D) states that all waters of the state, "…shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone." Excess concentrations of nutrients that contribute to non-attainment of biological criteria may fall under either OAC Rule 3745-1-04 (D) or (E) prohibitions.

The narrative rules establish the authority of the Ohio EPA to impart nutrient limits for watersheds where biological attainment is not met. However, numerical criteria have not been established. Ohio EPA staff developed a document, *Association between Nutrients, Habitat,* *and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA 1999), that relates total phosphorus concentrations to attainment of stream biology. This report was used for the water quality targets for the Ottawa River watershed TMDLs: 0.1 mg/l based on wadeable streams in Ohio (200 mi^2 > drainage area > 20 mi^2) designated as warmwater habitat. It is important to note that these nutrient targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility regarding their use in TMDL development.

4.1.4 Validation

The LDC method requires that the hydrology of the site is accurately represented by the relationship between the gage flow and the site flow. A series of flow measurements made at the Sugar Creek at CR-16 O were used to determine the accuracy of predicted streamflow measurements using drainage area-weighted flow data from the Ottawa River USGS stream gage station 04187100. Measurements were made at a range of flow levels (from interstitial or 0.0 cfs to 146 cfs actual measured flow) during the sampling season of 2010 (Table 4-6). Measured flows were compared with USGS daily average flows, for the day that the flow measurement was made, via a comparison to a 1-to-1 line that represents perfect agreement between the two values (Figure 4-1).

Table 4-6. Sugar Creek @ CR-16O measured flows versus predicted flows.

Date	Measured Flow	Drainage Area Yield Predicted Flow
9/14/2010	0.0	3.97
7/28/2010	2.25	13.6
3/24/2010	9.24	33.04
5/12/2010	145.67	185.6

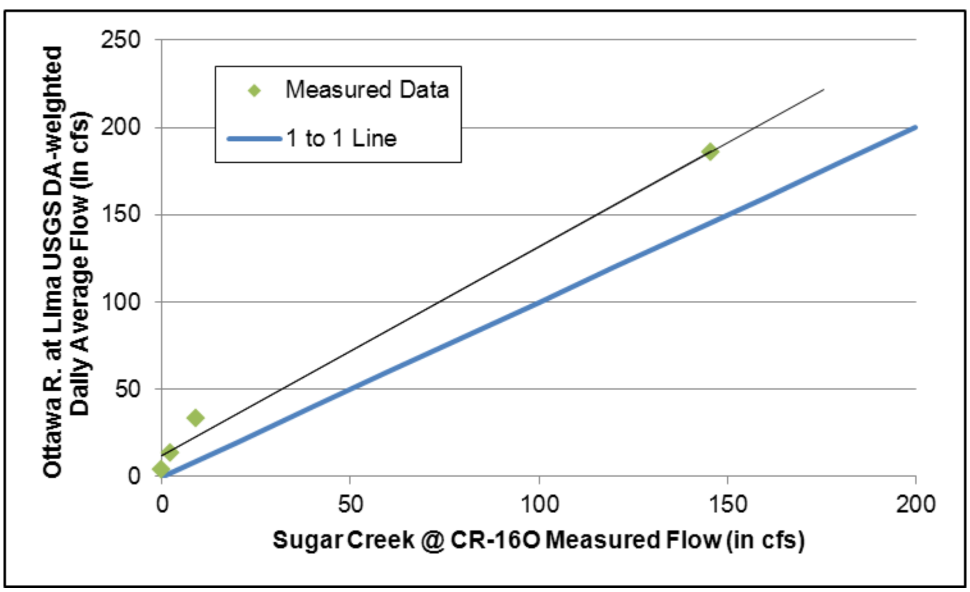


Figure 4-1. Regression of Sugar Creek at CR-16O measured flows vs. Ottawa River at Lima USGS drainage area weighted daily average flows.

4.1.5 Allowance for Future Growth

In order to use the LDCs for TMDLs an additional flow adjustment must be made. To account for expected future growth in the watershed, TMDLs require that permitted public waste water treatment facilities be allocated at their full permitted design flow. The additional flow must be added into the flow duration curve. Since this flow is expected no matter what the flow regime of the stream, the additional flow is added across all flow conditions. Adjustments that are made for additional future growth are discussed below.

Population projections for this watershed show insignificant growth in in the area contained in the watershed (U.S. Census Bureau 2012). Because of this, a relatively low allowance for future growth (AFG) of 2 percent is reserved from the TMDL.

4.1.6 Seasonality and Critical Conditions

Nutrient enrichment that affects the aquatic community is exacerbated by times of low flow where sunlight and temperatures are also not limiting. These conditions are associated with summer months when precipitation is typically the lowest, temperatures are the highest and daylight is the longest. These are the times that algae is least likely to be limited by anything other than nutrient availability. The result is the ability to reduce stress on aquatic communities by restricting algal growth by limiting nutrients. In systems where high nutrient inputs are not associated with these critical conditions there is still a link to aquatic life communities. Nutrients that are assimilated to the system during flow regimes outside of the critical condition can be released during the critical condition creating an internal nutrient source. This is especially true with phosphorus which often enters waters bound to sediment that can accumulate on the streambed. LDCs have the added benefit of providing the opportunity to allocate nutrient loads at all flow regimes, more completely managing their effects.

4.2 QUAL2K for Total Phosphorus

QUAL2K is a one-dimensional, steady-state model that is used to simulate dissolved oxygen (DO), carbonaceous biological oxygen demand (CBOD), algae as chlorophyll-a, organic and inorganic phosphorus, and the nitrogen series. The model considers stream re-aeration from the atmosphere and sediment oxygen demand among other processes. The study area is divided into a sequence of reaches (Figure 4-2) and within each reach there exists 1 - 4 elements where physical/chemical processes are simulated as a steady-state (invariant with time) phenomenon. Each reach is a river segment that has stable hydraulic characteristics (e.g. consistent slope, velocity, bottom width, etc.). While both the mainstem and tributaries can be modeled as interacting segments; the tributaries were considered as fixed inputs. The entire course of elements for all reaches is considered a series of linked, “completely mixed reactors.” Each element is treated as a separate system which has initial external inputs (from the previous element, baseflow additions, tributary, and wastewater inflow) and internal chemical reactions that either increase or decrease the modeled constituents.

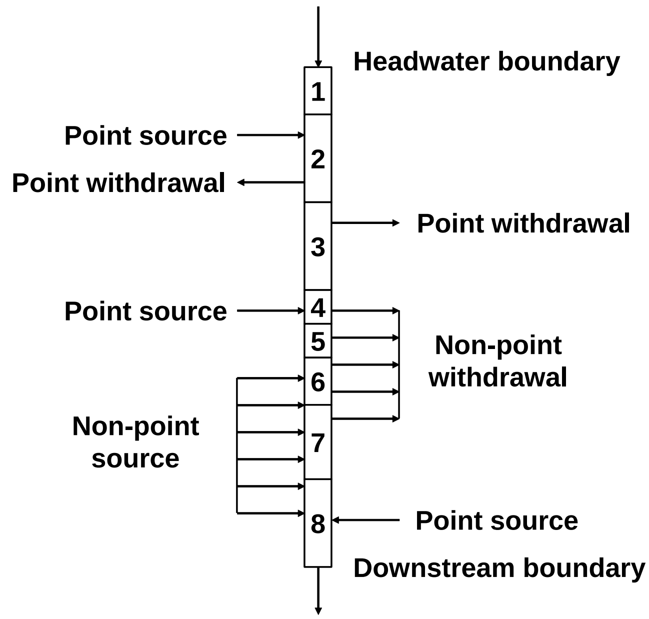


Figure 4-2. General segmentation scheme for the QUAL2K model showing reaches (numbered), boundary locations, and lateral inputs (or withdrawals). In this simplified scheme, tributaries are considered as fixed, point source inputs.

The Ottawa River (Lima) study area was divided into 15 reaches with a headwater boundary established at Thayer Road (RM 45.97) and a downstream boundary established at the crossing of Piquad Road (RM 25.8). Reaches have similar hydraulic characteristics or are controlled by a hydraulic structure such as a lowhead dam. Reach setup is critical in order to develop accurate hydrology for the modeled segment. See Appendix D for more details regarding the model set-up.

4.2.1 Justification

While TP LDCs are adequate in many situations for developing nutrient TMDLs, in other cases there are complicating factors including: large interactive point source dischargers and changing stream dynamics. The large point sources are exacerbated at a specific critical condition and warrant more effort to discern the impact at that critical condition. These situations limit the effectiveness of an empirical approach such as a LDC that examines a continuum of streamflow conditions. In this case the Ottawa River mainstem is not attaining aquatic life use (ALU) from RM 43.4 to 28.9 with a common cause of DO from nutrient enrichment *and* flow alterations (lowhead dams). Stream dynamics in this reach change drastically as the river moves from agricultural land use upstream of the city of Lima to urban/suburban land use within the city of Lima then back to an agricultural land use downstream of the city of Lima but with flow added by point sources within the city of Lima. Methods like LDCs do not account for the changing morphology of the stream especially when changes are this drastic. QUAL2K is an in-stream kinetics water quality model that allows more exact representation of the processes that affect water quality. Once calibrated and validated the model can be used to simulate critical stream conditions and compare strategies for remediation. QUAL2K was developed by Chapra and others (2008). The model is supported by U.S. EPA and is recommended for the development of TMDLs.

The strengths and weaknesses of QUAL2K also help to justify the use of the model in this scenario. QUAL2K explicitly grows algae, which are grown based on the availability of resources they need with nutrients being one of the major resources. This allows the nutrients to become dynamic in the system which allows for nutrient loading to be looked at not only as a mass balance, but also as from the standpoint of how the system responds to nutrient inputs. One weakness of QUAL2K is the inability to represent nonpoint source loads that are more important when stream flow is not dominated by point sources. The critical condition limits the exposure to the limitation because it is a time when point sources dominate the flow. However residual impacts from sources occurring outside of the critical condition are not fully accounted for. The bigger weakness in this scenario is that the model is for steady-state flow conditions. It is rare in nature and for wastewater treatment plants to be observed as a true steady state condition. Flow is a major parameter for determining concentrations and determining how long reactions have to occur so uncertainty in this area of the model can cause significant problems. Sampling for calibration and validation data at conditions that are nearly steady flow is a means to mitigate the problem

4.2.2 Sources of Data

Chemical data were collected at various sites along the Ottawa River upstream from, through and downstream from the city of Lima. Parameters included, but were not limited to, phosphorus, nitrogen, dissolved oxygen, pH, chlorophyll *a* and carbonaceous biochemical oxygen demand (CBOD). Physical parameters included, but were not limited to, temperature, flow and time of travel. Flow data from USGS gage 04187100 and Ohio EPA sentinel site data were used to calibrate and validate model-generated flows.

4.2.3 Target(s)

Phosphorus is considered to control the degree of enrichment and as a result targets discussed in this section are for phosphorus. Ohio Administrative Code (OAC) includes narrative criteria that limit the quantity of nutrients that may enter state waters. Specifically, OAC Rule 3745-1-04(E) states that all waters of the state, "…shall be free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae." In addition, OAC Rule 3745-1-04(D) states that all waters of the state, "…shall be free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone." Excess concentrations of nutrients that contribute to non-attainment of biological criteria may fall under either OAC Rule 3745-1-04 (D) or (E) prohibitions.

The narrative rules establish the authority of the Ohio EPA to impart nutrient limits for watersheds where biological attainment is not met. However, numerical criteria have not been established. Ohio EPA staff developed a document, *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA 1999), that relates total phosphorus concentrations to attainment of stream biology. This report was used for the water quality targets for the Ottawa River watershed TMDLs: 0.1 mg/l based on wadeable streams in Ohio (200 mi^2 > drainage area > 20 mi^2) designated as warmwater habitat. It is important to note that these nutrient targets are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility regarding their use in TMDL development.

4.2.4 Calibration and Validation

The interactions that are modeled by QUAL2K are not constant from one system to another, which makes calibration of the model necessary. The data used for calibration were collected on September 14, 2011. The data collected included: hydrology (flow and time of travel), Datasonde measurements (temperature, dissolved oxygen, pH and conductivity), stream chemistry (nutrients, CBOD, TSS, etc.), phytoplankton (chlorophyll *a*) and benthic algae (chlorophyll *a*). A subset of these components is presented in Appendix D in order to show the level of accuracy with which the model was able to match measured stream conditions.

Validation establishes the robustness of the model; in other words, how effective the model is at representing different conditions. In validation the rates and fixed environmental conditions that were specified to calibrate the model are left unchanged. The variable conditions include: chemistry inputs, flows and weather, are updated to a different point in time. The same field data collected for calibration were again collected for this point in time. The model is executed and model outputs are compared to the field data. Field data were collected on July 13, 2011 for model validation. Major differences in environmental condition were present in this survey, notably: flows were more stable (but of similar magnitude) and the Lima Refining Company was not discharging through its duration. Results of validation are presented in detail in Appendix D.

Error between model predictions and measured data is an important measure to describe the effectiveness of the modeling effort. As a tool to help discuss the errors associated with the model, the error is examined as relative error, which is the absolute value of the error. Two parameters are discussed based on the relevance to the modeling effort: total phosphorus and average dissolved oxygen. In the calibration model, the relative error for the two parameters is 12.52 percent and 7.46 percent, respectively. Much of the error in the total phosphorus is biased to the stream locations downstream from the major point sources in the watershed. Inaccuracies in adapting effluent grab samples as representative of daily discharge and non-steady state flows are contributing to errors downstream from the major point sources. Dissolved oxygen seems to be well represented by the model. The validation model was similarly analyzed and relative error was 50.01 percent for total phosphorus and 16.27 percent for dissolved oxygen. Further critique of the error shows a major bias of error to the region where lowhead dams are abundant. The extreme errors are not associated with extreme concentrations (relative to others observed in the stream). However, the measured total phosphorus concentrations are small in this reach and small magnitude errors lead to large percent errors. To demonstrate the impact of these errors on the relative error calculations, the values were excluded from the analysis and the percent error for the rest of the stream was 14.54 percent. Also, the stream the model fit downstream improved dramatically in the validation model compared to the calibration model, largely attributed to composite chemistry data collected at the major point sources.

4.2.5 Allowance for Future Growth

Population projections for this watershed show insignificant growth in the area contained in the watershed (U.S. Census Bureau 2012). Because of this, a relatively low allowance for future growth (AFG) of 2 percent is reserved from the TMDL. No future plans for expansion are known of at this time for any of the industrial facilities that are receiving allocations from this TMDL.

4.2.6 Seasonality and Critical Conditions

Nutrient enrichment that affects the aquatic community is exacerbated by times of low flow where sunlight and temperatures are also not limiting. These conditions are associated with summer months when evapotranspiration and temperatures are the highest and daylight is the longest. These are the times that algae is least likely to be limited by anything other than nutrient availability. The result is the ability to reduce stress on aquatic communities by restricting algal growth through nutrient limitation. The conditions are linked to dry weather conditions. Several NPDES permitted dischargers have separate permit conditions for treated flows that are linked to increased volume from the influence of storm water. The QUAL2K model does not address these flows and they are not considered linked to the nutrient-based impairment that is observed in the impaired portions of the Ottawa River downstream from the major point sources.

A set of critical conditions was constructed to represent the exiting load at permitted limits in the critical condition for nutrients affecting aquatic life. The point sources do not typically discharge at these levels; thus, this scenario represents a condition that is a greater load than the load that is currently impairing the stream. The critical flow condition is dictated by the cause of impairment that is being modeled. According to Ohio Administrative Code 3745-2-05, if the cause of impairment is an average water quality criterion, in this instance dissolved oxygen, 7Q10 flows should be used for modeling and wasteload allocations (WLAs). The 7Q10 flow is the flow regime representing the annual minimum 7 day average flow on a 10 year recurrence interval (Straub 1997). In this instance the final WLA is for total phosphorus because it is identified as the limiting nutrient for algal growth and associated eutrophication impacts.

Also associated with the critical condition are the weather conditions that have the greatest impact on the impairing cause. In this case, because algal production increases with temperature and light exposure, a long summer day with minimal cloud cover is used. The weather data from the validation model represented such a condition and to limit the exposure of the model to error July 13, 2011 data were used with the exception of eliminating the cloud cover. Point source discharges were added to the system at design effluent flows with permit limits established as constituent concentrations. The purpose of this approach is to maximize the loading potential and potential impact of the point sources on the system. In some instances the facility is required to monitor total phosphorus in its effluent. These samples were used to calculate an average projected effluent quality for the facility. The headwater chemistry dictating the background water quality was based on an average of samples collected by Ohio EPA and was biased to low flow samples (storm event samples were excluded).

4.3 Mass Balance for Combined Sewer Overflows

An empirical model uses monitoring data as a baseline for what reduction needs to take place in order to meet the target. The number of occurrences is the basis of the target but occurrences alone do not carry enough information to prescribe a reduction in pollution. The preference is to use a parameter such as overflow volume so something is not only known about the occurrence of the discharge but also the size of the discharge. Based on this logic an event size can be selected that if all smaller events are eliminated the average number of events in a given year will meet the target of five per year (based on the draft Lima long-term control plan). The purpose of the empirical model is to analyze the data and determine the overflow volume that can occur and eliminate all but five occurrences per year. Based on the information from the empirical model and statistical analysis of other pollutant sources, allocations for the TMDL were completed using a mass balance.

4.3.1 Justification

The use of predictive modeling is necessary to perform loading analysis when data are limited and the critical condition is not easily monitored. However, when large datasets are available direct observations can be used to perform a loading analysis. The large dataset available from the city of Lima is favorable to perform a loading analysis using observed data by developing an empirical model.

4.3.2 Sources of Data

As required by the NPDES permit for the city of Lima WWTP, the city reports the following for five CSO discharge stations: overflow occurrences, overflow volume and carbonaceous biological oxygen demand 5-day ($CBOD_5$) concentration of the discharge. Modeling done for the city of Lima's draft long term control plan indicates these five stations account for the majority of the overflow volume discharged to the Ottawa River (MWH Global, Inc. 2012).

4.3.3 Target(s)

CSOs are unique from other point source discharges as they are intermittent in nature and discharge occurrences are linked exclusively to wet weather events. Discharge quality is also variable depending on when the sample is taken (temporally) and where the sample was taken (spatially). During the wet weather events that trigger a CSO discharge the streamflow also changes rapidly both temporally and spatially. The variability present within the system makes capturing and quantifying a specific water quality based target difficult. As a result, Ohio EPA has relied on a target that limits the number of discharges that occurs in a year as opposed to the quality of any single discharge. The target that is being negotiated for the city of Lima is a combined sewer system that overflows an average of five times per year (MWH Global, Inc. 2012). The nature of CSO mitigation means that these will likely be the highest flows that the CSOs discharge when there is the most potential for dilution. Also mitigation will likely capture the first flush from the sewer system that is generally higher in pollutant concentration from sediment that accumulated in sewer lines. These factors combine to limit the impact of the remaining CSO discharges on stream aquatic life.

4.3.4 Calibration and Validation

According to the city of Lima's draft long-term control plan, 41 occurrences are expected in a typical rainfall year with a total overflow volume of 407.6 million gallons. Based on 13 years of reported data there was an average of 36 occurrences per year. This assumes that minor CSOs that do not report flow do not discharge as separate occurrences. While it is not possible to accurately report total volume because of limited overflow volume data, an average of 402.9 million gallons per year is discharged from five stations that report overflow volume. Agreement between the two different approaches provides some certainty that the data used to perform the loading analysis are sufficient.

4.3.5 Allowance for Future Growth

There is no indication of expected population growth in Allen or Hardin counties where the Ottawa River watershed is located (U.S. Census Bureau 2012). Allen County, which contains the majority of the watershed, is actually expecting a negative population shift. Therefore; a low but reasonable allowance for future growth of 2 percent is used.

4.3.6 Seasonality and Critical Conditions

The target for this TMDL (five occurrences per year) makes it necessary to define what constitutes an occurrence. Exploring the nature of CSOs is necessary to define what an occurrence is, which leads into the definition of the critical condition for this TMDL. CSOs occur in a manner that is both spatially and temporally variable. To explain the spatial distribution of CSO impacts a short discussion of why CSOs occur is warranted. There are two scenarios that can cause a CSO to occur:

1) The wastewater treatment plant is overwhelmed and additional flow must be bypassed.
2) The piping network is overwhelmed at some point and must be allowed to overflow to relieve pressure.

The city operates the network to ensure that the maximum amount of flow reaches the treatment plant. However, once the network reaches capacity overflows can occur at 19 permitted locations to reduce stress on the system. It is still possible that the upstream overflows occur without the occurrence of a downstream overflow. The result of the spatial variability of CSOs is the definition of an occurrence. An overflow from any combination of points within the system in a 24 hour period is counted as one occurrence. For example, the piping network is locally overwhelmed and an overflow occurs at an upstream relief point; this counts as one occurrence. A contrasting example is a large precipitation event occurs and the capacity of the treatment plant is overwhelmed as well as the piping network and all 19 permitted locations report an overflow; this still counts as one occurrence. Distribution of discharge locations begins to explain the spatial variability in impairments caused by CSO occurrences. Impairment is also influenced by variability in the stream system and is exacerbated by locations where settling is maximized (i.e., dam pools).

Temporal distribution of events refers to occurrences being discrete events. The temporal distribution can take on greater meaning in that occurrences are more frequent seasonally. Local peaks in May and November identify a degree of seasonality for CSO occurrences in late spring and early fall (Figure 4-3).

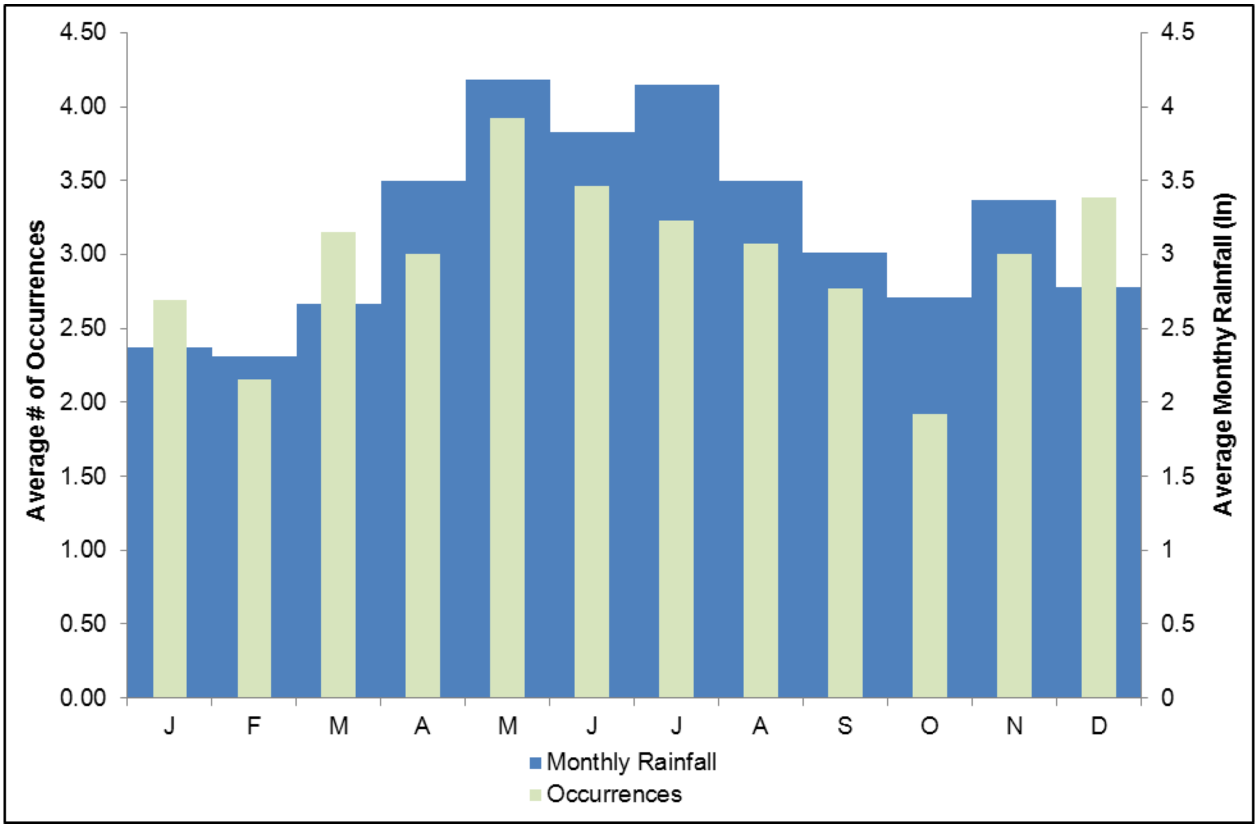


Figure 4-3. Historical average monthly precipitation for Lima, Oh and average number of CSO discharge occurrences based on 13 years (1999 – 2011) of observed data.

Now that there is a better understanding of where, when and why CSOs occur, the critical condition as it applies to developing a TMDL can be discussed. The critical condition can take on two meanings with regard to CSOs:

1) The condition in which an occurrence is induced.
2) The condition in which aquatic life is impaired by the occurrence.

Based on the above discussion, we assume these two conditions do not occur simultaneously. As a result it is not possible to develop a TMDL scenario where the load of a pollutant is addressed in the same flow condition the aquatic life is impaired by the load. The critical condition argument is based on the residual impact of CSO loads on dissolved oxygen through organic enrichment. However, mitigation strategies will likely reduce the risk of exposure to acute toxicity impacts from CSOs. The result is the definition of the critical condition that was used to conduct the loading analysis: The critical condition for TMDL calculations is the five CSO occurrences that are the most difficult to eliminate. For the purposes of the TMDL these were assumed to be the largest events with regard to total volume discharged.

These two conditions vary both spatially and temporally. Occurrences are induced by both the volume and intensity of a precipitation event. CSO occurrences have local peaks in May and November with the highest number of occurrences occurring in May based on 13 years of data (Figure 4-3). These peaks represent the temporal distribution of occurrences. However, the aquatic life is indicated to be impaired by organic enrichment, which is exacerbated by low flows and warm temperatures. These conditions are typically associated with summer months. From

Figure 4-3 it can be observed that occurrences remain high through summer months but summer occurrences are associated with high intensity rains and temporary high flows.

4.4 Habitat and Sediment Bedload Analysis

Habitat alteration is a cause of impairment in multiple locations in the watershed. Poor habitat quality is an environmental condition, rather than a pollutant load, so development of a load-based TMDL for habitat is not possible. Nonetheless, habitat is an integral part of stream ecosystems and has a significant impact on aquatic community assemblage and consequently on the potential for a stream to meet the biocriteria within Ohio's water quality. In addition, U.S. EPA acknowledges that pollutants, conditions or other environmental stressors can be subject to the development of a TMDL to abate those stressors in order to meet water quality standards. Thus, sufficient justification for developing habitat TMDLs is established.

In quantifying the sediment and habitat TMDLs for the Ottawa River watershed, only sites with either ALU partial or non-attainment were considered. Sites having full attainment were excluded and hence do not appear in tables. Further, of these sites, only those with causes identified as siltation/sedimentation and/or habitat alteration were considered for sediment TMDLs. Correspondingly, only those sites with habitat alteration, sedimentation/siltation, turbidity, and/or flow alteration (non-natural) were considered for a habitat TMDL.

4.4.1 Justification

Habitat

A consequence of habitat degradation not being a pollutant per se is that methods used to conduct traditional loading analyses are incompatible. The QHEI score does have a strong correlation to biological criteria and thus serves as a useful target if habitat is to be eliminated as a factor limiting aquatic life.

Sediment

The rationale for using the QHEI for development of the sediment TMDL is largely due to the problems linked to other methods of evaluating sediment loading and the limited reliability that results. For example, the measurement of total suspended solids (TSS) is commonly used as a loading parameter; however, gathering data that is reliable for calibration and validation is often uncertain. This uncertainty rests in the fact that TSS demonstrates a high degree of variability both over space and time and is sensitive to local disturbances.

Finally, the QHEI has a strong relationship with the bio-criteria in Ohio's water quality standards, whereas TSS has a relatively weak correlation with biological performance, which is probably related to the variability and unreliability of TSS measures. The QHEI measures the end result of high sediment loading (either from the landscape or in-stream sources) as it impacts the biological community.

4.4.2 Sources of Data

QHEI data were collected by Ohio EPA during 2010 biological field sampling. Targets for WWH streams were developed using statewide Ohio EPA QHEI data, as described in Section 4.4.3.

4.4.3 Target(s)

Habitat

Since its development the QHEI has been used to evaluate habitat at most biological sampling sites and currently there is an extensive database that includes QHEI scores and other water quality variables. Strong correlations exist between QHEI scores and some its component sub-metrics and the biological indices used in Ohio's water quality standards such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). For the aquatic life use designation of warmwater habitat (WWH) an overall QHEI score of 60 is targeted to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the bio-criteria (Table 4-8).

Many of the sites in the Ottawa River study area that are listed as impaired due to habitat are designated as modified warmwater habitat (MWH). Targets for habitat do not exist for these streams but standards for biological indices are established making it possible for the sites to be assessed for attainment. There is a reasonable expectation that, even in MWH systems where lower biological standards are in place, habitat that is degraded to some extent will influence biological attainment. The method for establishing habitat targets involved determining the percent reduction in standards for biological indices. The sites in the Ottawa River assessment area that were both MWH and listed as impaired by habitat are headwater streams. To develop QHEI targets for these systems differences a ratio of expectations for biological indices between WWH and MWH for these sites was used. The percent reduction in the two biological indices, index of biological integrity (IBI) and invertebrate community index (ICI), are 28.6 percent and 35.3 percent respectively. The percent reduction calculated for the IBI results in a higher relative score for the metrics (i.e., QHEI of 43 vs. 39) used in habitat TMDLs. The higher QHEI value is chosen to err on the side of protective of aquatic life. The ratio was applied to the metrics used to establish habitat targets for MWH, which are presented in Table 4-8.

One of the strongest correlations found through these statistical analyses described above is the negative relationship between the number of "modified attributes" and the IBI scores (Table 4-7). Modified attributes are features or conditions that have low value in terms of habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger impact on biological performance; these are termed "high influence modified attributes" (Table 4-7).

Table 4-7. Itemization of "modified attributes" for computing the habitat TMDL.

High Influence Modified Attributes	Moderate Influence Modified Attributes	
• Channelized or no recovery • Silt/muck substrate • Low sinuosity • Sparse/no cover • Maximum pool depth < 40 cm (wadeable streams only)	• Recovering channel • Heavy/moderate silt cover • Sand substrate (boat sites) • Hardpan substrate origin • Fair/poor development • Low sinuosity • Only 1-2 cover types	• Intermittent and poor pools • No fast current • High/moderate overall embeddedness • High/moderate riffle embeddedness • No riffle

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than 4 modified attributes of which no more than 1 should be a high influence modified attribute (Table 4-8). For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. If the minimum target is satisfied, then that category is assigned a "1," if not, it is assigned a "0." To satisfy the habitat TMDL, the stream segment in question should achieve a score of three (Table 4-8). Using the same methodology describe above for setting MWH targets for overall QHEI scores number of high and moderate influence attributes are adjusted. The difference is that these targets are increased, as opposed to reduced which is the case for overall QHEI scores.

Table 4-8. QHEI-based targets for the sediment TMDL.

Habitat TMDL Targets			
	Target		
QHEI Category	*WWH*	*MWH*	*Score*
QHEI Score	≥ 60	≥ 43	+ 1
High Influence #	≤ 1	≤ 2	+ 1
Total # Modified	≤ 4	≤ 6	+ 1
Habitat TMDL ►		+ 3	

Sediment

The QHEI is also used in developing the sediment TMDL for this project. Numeric targets for sediment are based upon sub-metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component sub-metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system.

The QHEI sub-metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion and riparian zone. Table 4-9 lists targets for each of these metrics for WWH aquatic life use designation.

- The substrate sub-metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the sediment loading.
- The channel morphology sub-metric considers sinuosity, riffle, and pool development, channelization, and channel stability. Except for stability each of these aspects are directly related to channel form and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion, which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone sub-metric also reflects the likely degree of in-stream sediment sources. The evaluation of floodplain quality is included in this sub-metric which is related to the capacity of the system to assimilate sediment loads.

Similarly to the MWH targets derived for habitat, MWH targets for sediment TMDLs also had to be derived. The same logic was followed and percent reduction in the standards for IBI scores in headwater streams were used (Table 4-9).

Table 4-9. QHEI-based targets for the habitat TMDL.

Sediment TMDL Targets		
	Target	
QHEI Category	*WWH*	*MWH*
Substrate	≥ 13	≥ 9
Channel	≥ 14	≥ 10
Riparian	≥ 5	≥ 4
Sediment TMDL ►	≥ 32	≥ 23

4.4.4 Seasonality and Critical Conditions

The critical condition for the habitat and bedload TMDLs is the summer when low flows and high temperatures persist and environmental stress upon aquatic organisms is greatest. It is during this period that the presence of high quality habitat features, such as deep pools and un-embedded substrate, is essential to provide refuge for aquatic life. QHEI scores, the basis of the habitat TMDLs, are assessed during the summer field season. The habitat and bedload TMDLs are therefore reflective of the critical condition.

Habitat is generally a relatively static condition of a stream. Exceptions include major modifications made by humans (or animals such as beavers) or changes in the hydrology or sediment loading of the watershed, which is typically a human-caused situation. Because habitat is relatively static, seasonality has little meaning. Specifically, absent a major disturbance, habitat quality does not change across the seasons but rather over much longer timescales (years to decades). Finally, there is no seasonal “loading” associated with habitat but instead habitat evolves through changes in morphology and riparian vegetation. However, in terms of sediment, seasonality does have meaning. For example, agricultural areas yield the highest loads when fields have minimal vegetative cover and runoff events occur. This corresponds to the spring pre-plant season. In-stream sources of sediment from bed or bank erosion are also seasonally loaded when flows are highest and banks are saturated. When stream banks are saturated, they are more susceptible to erosion through slip failure. As with upland loads, spring is an important time as well as mid to late fall.

4.5 Load Duration Curves for *E. coli*

Recreation use was not supported in multiple assessment units where the geometric mean of at least one stream sampling site did not meet its water quality standard. Twenty sites were sampled as a part of the Ohio EPA’s monitoring and assessment in 2010 to determine recreation use attainment, and all 20 (100 percent) were found to be in non-attainment.

This study was carried out to develop *E. coli* total maximum daily loads (TMDL) as required by Section 303(d) of the Clean Water Act and the United States Environmental Protection Agency’s Water Quality Planning and Management Regulations (Title 40 of the Code of Federal

Regulations, Part 130). This report defines in-stream bacteria conditions, potential sources, bacteria targets and needed reductions and recommends implementation strategies.

For a given impaired site, each hydrologic condition (high flows, wet weather conditions, normal range conditions, dry weather conditions or low flows) was assigned a target bacteria loading rate (cfu/day) by multiplying the Class A *E. coli* water quality standard, 126 cfu/100 ml, by the median flow of each hydrologic class at that site and a constant, used to convert cubic feet per second to milliliters per day: $T = Q_m * S * C$; where T = target bacteria load, Q_m = median flow for a specific hydrologic class, S = water quality standard (126 cfu/100 ml) and C = a unit conversion constant (cubic feet per second to milliliters per day). Median observed bacteria loads in each hydrologic condition were compared to the median target value in that condition, after incorporating a margin of safety and allowance for future growth, in order to quantify needed reductions.

Each sanitary discharger is assigned a wasteload allocation (WLA) based upon the design flow of the treatment facility and the water quality standard applicable to its receiving water. These WLAs are listed in the TMDL table that corresponds with each sampling site in Section D5. Because any facility operates at most times at some fraction of its design flow, the WLA for these facilities includes reserve capacity up to the design flow.

The Lima WWTP is unique as a point source in that they receive many allocations based on the wet weather design capacity. When operating in wet weather conditions the plant has in its most recent permit a schedule to increase the capacity up to 70 MGD compared to the dry weather design capacity of 18.5 million gallons per day. The difference in these to operational conditions results in significant increase in total load at the high flow condition. The result is a need to account for the load of the wet weather design condition in the *Wet Weather* and *High* flow ranges. As a result the Lima WWTP receives a higher WLA in the specified flow regimes when wet weather plant operation is expected.

The wasteload allocation for each facility is accounted for in each downstream site’s LDC in the watershed; for example, the WLA for Lima WWTP is included in the LDC of the most immediate downstream site, *Ottawa River @ Shawnee Rd (RM 35.44)*, as well as *Ottawa River @ Copus Rd (RM 29.26)* and *Ottawa River @ US-224 (RM 3.67)*.

Allocations for the regulated MS4 in this watershed were determined based on the area of the MS4 draining to each assessment location. Townships, municipalities, and urbanized areas as documented in geographic information system (GIS) database files were used to determine the total regulated area for the MS4. These areas were then used to calculate WLAs based on the proportion of the upstream drainage area located within the MS4 boundaries. Storm water runoff was only assumed to occur during *High*, *Wet Weather* and *Normal Range* flow conditions.

In many cases in the Ottawa River and its tributaries, there is a scenario in which low flows the point sources dominate the stream flow. As a result the streams ability to assimilate pathogen loads is decreased and the TMDL is exceeded. There is more certainty at this flow condition as to the source of the load (point sources). These sources are given limits that they are required to meet through the NPDES permitting process. As a result there is less uncertainty that needs to be accounted for with an explicit margin of safety. Where these cases occur a footnote is included with the allocations table in Section D4.3 and the MOS is reduced to 10 percent in the lowest flow regime.

4.5.1 Justification

The load duration curve method was selected to assign in-stream pollutant loads at a given site to one or several potential pollutant sources (see U.S. EPA 2007). In a load duration curve, patterns of impairment can be examined and addressed relative to the flow conditions under which they occur, and this allows a set of potential pollutant sources specific to a given site to be highlighted. Under the highest flow conditions, point sources are likely to be masked by in-stream dilution; therefore high pollutant levels in these conditions are associated with precipitation wash-off or erosion of contaminated land surfaces. Impairments under normal range flows can be caused by a mixture of point and nonpoint sources. Under the lowest flow conditions, recreation use impairments are generally attributable to sources not associated with runoff events, such as a failing HSTS, point source discharge or in-stream livestock.

Many modeling techniques for bacteria are time consuming and are often found by Ohio EPA to yield results that are difficult to properly calibrate. For adequate calibration, this type of modeling requires additional bacteria data that are not collected during routine surveys. An empirical method of determining TMDL bacteria loading and reductions is utilized in this report via load duration curves (LDCs). This method is appropriate since the sources of bacteria in Ohio streams can be differentiated by streamflow regime. The main advantage of the use of LDCs is in this methods ability to divide loads based on flow.

4.5.2 Sources of Data

Most sites with LDCs developed to be TMDLs are at what Ohio EPA refers to as sentinel sites. These sites are picked to represent nested subwatersheds and/or important drainage areas. The sites are sampled more frequently than the other survey sites. Water stage to stream discharge rating curve relationships are also created for each sentinel site. Knowing the stream discharge at each sampling of these sites allows for load calculations to be made without relying on the extrapolations to stream gages.

Of the 20 sites found to be in recreation use non-attainment during the summer of 2010, a subset of eleven sampling locations was established on the mainstem and tributary streams within the watershed, and these sites were used for further study of the causes of recreation use non-attainment in non-attaining nested sub-watersheds (12-digit hydrologic units). These eleven sites included three sites on the mainstem of the Ottawa River and eight tributary sites. Nested subwatersheds addressed by these LDCs are shown in Table 4-10.

Table 4-10. Nested subwatersheds that are represented by LDC sites.

Load Duration Curve Site	Nested Subwatershed Location (04100007)	Nested Subwatersheds Represented (04100007)
Hog Ck. (RM 0.27) N of Lafayette @ Swaney Rd.	03 04 [1]	03 02 03 04
Lost Ck. (RM 0.35) @ E. High St., lower crossing	03 05	03 05
Ottawa R. (RM 35.44) at Lima @ Shawnee Rd.	03 06	03 03 03 06
Little Ottawa R. (RM 0.03) at Fort Amanda Rd.	04 01	04 01
Ottawa R. (RM 29.26) @ Copus Rd.	04 02	04 02 (excluding Honey Run)
Honey Run (RM 0.9) @ Wapak Rd.	04 02	04 02 (Honey Run only)
Ottawa R. (RM 3.67) @ US-224	04 03	04 03 04 06
Pike Run (RM 0.84) Lima-Gomer Rd.	04 04	04 04
Leatherwood Ditch (RM 1.67) @ Putnam CR-U	04 05	04 05
Sugar Creek (RM 0.6) @ CR-O	05 01	05 01
Plum Ck. (RM 0.19) W. of Kalida @ SR-114	05 02	05 02

[1] This LDC includes nested subwatershed 03 01 if data collected in the future show impairment.

4.5.3 Target(s)

TMDL numeric targets for *E. coli* bacteria are derived from bacteriological water quality standards. The criteria for *E. coli* specified in OAC 3745-1-07 are applicable outside the effluent mixing zone and vary for waters determined as primary contact recreation (PCR). Furthermore, this criterion designates streams that support frequent primary contact recreation—Class A streams. The Ottawa River mainstem is designated as Class A. All other sites sampled in the watershed lie within 5 river miles of the Ottawa River mainstem and are held to the Class A standard in order to protect downstream Class A recreation use on the Ottawa River. For Class A streams, the standard states that the geometric mean of more than one *E. coli* sample taken in each recreational season (May 1 through October 31) shall not exceed 126 colony-forming units (cfu) per 100 ml.

A Class B PCR target curve is also depicted on each LDC plot (see Appendix D), due to local interest and for informational purposes only. The dashed line on each LDC curve represents the TMDL curve as it would appear if the mainstem of the Ottawa River were designated as Class B (vs. Class A) for recreation use and a standard of 161 cfu per 100 mL (vs. 126 cfu per 100 mL) were used for all LDC sites. Adoption of the more lenient Class B standards would not affect the attainment status of any non-attaining subwatersheds, based on 2010 sampling results. In order to avoid potential confusion, because the Class B standard was not used to establish TMDLs, calculations related to a Class B recreation use standard are not included in any associated TMDL tables.

4.5.4 Calibration and Validation

Flows were validated as discussed in Section 4.1.4.

4.5.5 Allowance for Future Growth

Population projections for this watershed show insignificant growth (U.S. Census Bureau 2012). As a result, a relatively low allowance for future growth is reserved from the TMDL load—2 percent.

4.5.6 Seasonality and Critical Conditions

Critical conditions for bacteria are difficult to define as they vary by source. The critical conditions are often defined by flow regime and likely sources during different flow regimes were identified in Table 4-4. The variability in critical conditions for different bacteria sources is a strong reason for the use of LDCs because they are able to cover multiple flow regimes. Seasonality is important for bacteria TMDLs since water quality standards for *E. coli* only apply to the recreation season, between May 1 and October 31. Samples for assessment are only collected in this timeframe and hydrology used to determine flow intervals is only from this time period.

4.6 Margin of Safety

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

4.6.1 Load Duration Curves for Total Phosphorus

An explicit margin of safety (MOS) is used for Ottawa River TMDLs derived from nutrient LDCs. The MOS is used to account for uncertainty in the response of the waterbody to loading reductions. A 5 percent MOS is applied to account for the limited data available for this analysis. For LDC TMDLs, U.S. EPA (2007) recommends this type of MOS for two reasons:

1) Allocations will not exceed the load associated with the minimum flow in each regime.
2) Recognition that the uncertainty associated with effluent limits and water quality may vary across different flow conditions.

4.6.2 QUAL2K for Total Phosphorus

With the available information the model was calibrated and validated to the best possible fit of field data. However due to weaknesses in the model and field data collection model error is inevitable. In order to determine what margin of safety is adequate to protect aquatic life a quantification of the standard error present in the model was applied. The purpose of the margin of safety is to be protective of the use that is addressed by the modeling effort (aquatic life). As a result the under prediction errors are used to establish a margin of safety. The calibration model had a maximum under prediction of 21.8 percent and the validation model had a maximum under prediction of 17.3 percent for total phosphorus. Phosphorus is ultimately used as the target in the stream; therefore, the margin of safety is based on error in predicting phosphorus concentrations. To ensure protection of aquatic life the margin of safety is set as the more conservative value from the calibration model, 21.8 percent.

4.6.3 Mass Balance for Combined Sewer Overflows

Conservative assumptions provide an implicit margin of safety in a model. In this loading analysis many conservative assumptions were made including using the 75th percentile values for the following:

1) $CBOD_5$ concentration of the pollutant in the CSO discharge
2) CSO discharge volume
3) Background $CBOD_5$ concentration
4) Streamflow corresponding to occurrences

The model does have limitations however, such as:

1) Uses flow data from all CSO discharge locations; however, the five used are expected to account for the majority of the volume discharged.
2) CSO discharges are treated as a continuous daily discharge but in reality will occur over a shorter time period (the flow volume in million gallons is treated as a flow rate, million gallons per day).

While conservative assumptions imply an implicit margin of safety (MOS) an additional 20 percent explicit MOS was used to account for additional model uncertainty. The explicit MOS was applied to both mitigation value (eliminated overflow volume) and the TMDL allocations for $CBOD_5$. If assumptions were made less conservatively, the explicit MOS would have had to be higher to account for the variability in the data driving the model and flows that are not explicitly included in the model development.

4.6.4 Habitat and Bedload Analysis

Despite the fact that a numerical value within a QHEI score is derived qualitatively, subjectivity is minimized because scores are based on the presence and absence and relative abundance of unambiguous habitat features. Reduced subjectivity was an important consideration in developing the QHEI and has since been evidenced through minimal variation between scores from various trained investigators at a given site as well as consistency with repeated evaluations (Ohio EPA 1989b). The consistency of the method reduces uncertainty and thus implicitly implying a margin of safety (MOS).

Additional implicit MOS is incorporated into the habitat and sediment TMDLs through the use of conservative target values. The target values were developed though comparison of paired IBI and QHEI evaluations. Using an IBI score of 40 as representative of the attainment of WWH, individual components of the QHEI were analyzed to determine their magnitude at which WWH attainment is probable (Ohio EPA 1999). However, attainment can occur at levels lower than the established targets. The difference between the habitat and sediment targets and the levels at which attainment actually occurs is an implicit MOS.

4.6.5 Load Duration Curves for *E. coli*

An explicit margin of safety (MOS) is computed in the Ottawa River TMDLs. The MOS is used to reserve assimilative capacity and accounts for uncertainty in the LDC approach and in monitoring information. A 20 percent MOS is applied to account for fluctuations of *E. coli* concentrations that occur in nature and the relatively low number of data points available for this analysis. For LDC TMDLs, U.S. EPA (2007) recommends this type of MOS for two reasons:

1) Allocations will not exceed the load associated with the minimum flow in each regime.
2) Recognition that the uncertainty associated with effluent limits and water quality may vary across different flow conditions.

5 LOAD REDUCTION RESULTS

Several analyses were completed to address the causes of impairment. Results are summarized in this chapter and organized by assessment unit (nested subwatershed). Further details are available in Appendix D.

5.1 Middle Hog Creek (04100007 03 02) and Lower Hog Creek (04100007 03 04)

Total phosphorus reductions ranged from 0 percent to 67.0 percent in these nested subwatersheds. *E. coli* reductions ranged from 24.1 percent to 98.5 percent. Additional TMDLs included sediment.

Table 5-1. Total phosphorus TMDL table: Hog Ck @ Swaney Rd

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	3	0	3	1	0
Median Sample load	372	N/A	1.75	2.91	N/A
Total Load Reduction Required	**66.9%**	No Data	**NA**	**67.0%**	No Data
Total Maximum Daily Load	132.99	12.01	3.56	1.48	0.91
Margin of Safety*: 5%	6.65	0.60	0.18	0.07	0.04
Allowance for future growth: 2%	2.66	0.24	0.07	0.03	0.02
Load Allocation	122.83	10.32	2.46	0.53	0.01
Wasteload Allocation Total	0.85	0.85	0.85	0.85	0.85
Ada WWTP 2PB00050	0.85	0.85	0.85	0.85	0.85

Values were adjusted for rounding; *MOS reduced to 4% in low flow regime.

Table 5-2. Characterization of the sediment TMDL in the Lower Hog Creek nested subwatershed.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Categories			Total Sediment Score	Deviation from Target (%)	Main Impairment Category
		Substrate	Channel	Riparian			
03 04 Hog Creek – Ottawa River							
Hog Ck (WWH)[1]	3.80	20	12.5	6.5	39	---	channel
Target (MWH)		**≥ 9**	**≥ 10**	**≥ 4**	**≥ 23**		
Target (WWH)		**≥ 13**	**≥ 14**	**≥ 5**	**≥ 32**		

[1] Substrate assessed based on data collected at RM 0.3 because data were unavailable at RM 3.8; the land use and channel characteristics between the two sites do not differ substantially.

Note that the LDC in Table 5-3 includes the Upper Hog Creek (04100007 03 01) nested subwatershed. Although Ohio EPA did not collect data in this nested subwatershed, reductions are needed because the nested subwatershed drains into Hog Creek.

Table 5-3. *E. coli* TMDL table: Hog Creek @ Swaney Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	2	3	6	1	0
Median Sample load	69550	131	53.68	14.61	N/A
Total Load Reduction Required	**98.5%**	**36.2%**	**49.0%**	**32.5%**	No Data
Total Maximum Daily Load	1314.73	116.34	44.61	23.64	14.77
Margin of Safety: 20%*	262.95	23.27	8.92	4.73	1.48
Allowance for future growth: 2%	26.29	2.33	0.89	0.47	0.30
Load Allocation	1013.30	78.56	22.60	6.25	0.81
Wasteload Allocation Total	12.19	12.19	12.19	12.19	12.19
Ada WWTP 2PB00050	12.19	12.19	12.19	12.19	12.19

Values were adjusted for rounding.
*10% in Low flow regime

5.2 Little Hog Creek (04100007 03 03) and Lima Reservoir-Ottawa River (04100007 03 06)

Total phosphorus reductions ranged from 0 percent to 77.1 percent in these nested subwatersheds. *E. coli* reductions ranged from 75.8 percent to 94.7 percent. Additional TMDLs included total phosphorus via QUAL2K, $CBOD_5$, sediment and habitat.

Table 5-4. Total phosphorus TMDL table: Mud Run @ Bluffton Bentley Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	2	0	3	0	0
Median Sample load	47	N/A	0.42	N/A	N/A
Total Load Reduction Required	**76.9%**	No Data	**37.7%**	No Data	No Data
Total Maximum Daily Load	11.66	1.01	0.28	0.08	0.02
Margin of Safety: 5%	0.58	0.05	0.01	0.004	0.001
Allowance for future growth: 2%	0.23	0.02	0.01	0.002	0.0004
Load Allocation	10.84	0.94	0.26	0.07	0.02
Wasteload Allocation Total	0.00	0.00	0.00	0.00	0.00

Values were adjusted for rounding.

Table 5-5. Total phosphorus TMDL table: Little Hog Ck @ Peevee Rd

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	2	0	2	1	0
Median Sample load	71	N/A	0.32	0.05	N/A
Total Load Reduction Required	**71.7%**	No Data	**N/A**	**N/A**	No Data
Total Maximum Daily Load	21.70	1.85	0.46	0.12	0.03
Margin of Safety: 5%	1.09	0.09	0.02	0.01	0.001
Allowance for future growth: 2%	0.43	0.04	0.01	0.002	0.001
Load Allocation	20.18	1.72	0.43	0.11	0.03
Wasteload Allocation Total	0.00	0.00	0.00	0.00	0.00

Values were adjusted for rounding.

Table 5-6. Total phosphorus TMDL table: Zurmehly Creek @ Ft. Amanda Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	3	3	0	0
Median Sample load	N/A	2	0.11	N/A	N/A
Total Load Reduction Required	No Data	**77.1%**	**NA**	No Data	No Data
Total Maximum Daily Load	5.74	0.50	0.14	0.04	0.01
Margin of Safety: 5%	0.29	0.02	0.01	0.00	0.00
Allowance for future growth: 2%	0.11	0.01	0.00	0.00	0.00
Load Allocation	3.04	0.26	0.07	0.04	0.01
Wasteload Allocation Total	2.30	0.20	0.05	0.00	0.00
Lima MS4	2.30	0.20	0.05	0.00	0.00

Values were adjusted for rounding.

Table 5-7. Total phosphorus TMDL and supporting allocations for the modeled stream reach using QUAL2K.

	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
Load (nonpoint source)	-	0.000267	**0.04**
Wasteload (total point sources)			**10.58**
2IJ00013 (National Lime & Stone)	0.015	-	0.11
2PE00000 (Lima WWTP)	0.0762	-	5.33
2IG00001 (Lima Refining Company)	0.0762	-	1.58
2IF00004 (PCS Nitrogen)	0.0762	-	1.25
2PK00002 (Shawnee #2 WWTP)	0.305	-	2.31
Margin of Safety: 21.8%	-	-	**3.03**
Allowance for future growth: 2%	-	-	**0.28**
TMDL = LA + WLA + MOS + AFG			13.93

Table 5-8. $CBOD_5$ TMDL allocations for the Lima Reservoir-Ottawa River nested subwatershed.

	$CBOD_5$ Load (kg/day)
Total Maximum Daily Load	**20,676.45**
Margin of Safety: 20%	**3,389.58**
Allowance for future growth: 2%	**338.96**
Load Allocation	**5,253.72**
Wasteload Allocation Total	**11,694.19**
Lima MS4	1,263.14
County Line Invest. LLC 2PW00018	0.14
Ada WWTP 2PB00050	93.38
Colonial Golfer's Club 2PR00195	0.35
LaFayette WWTP 2PA00049	4.67
National Lime & Stone Co 2IJ00013	62.25
Lima Combined Sewer Overflows[1]	3,336.50
Lima Sanitary Sewer Overflows	0
PCS Nitrogen 2IF00004	186.31
Lima Refinery 2IG00018	1,293.00
Lima WWTP 2PE00000	5,454.45

[1]Includes outfalls: 002, 003, 004, 005, 006, 007, 008, 009, 033, 034, 035, 036, 037

Table 5-9. Characterization of the sediment TMDL in the Little Hog Creek and Lima Reservoir-Ottawa River nested subwatersheds.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Categories			Total Sediment Score	Deviation from Target (%)	Main Impairment Category
		Substrate	Channel	Riparian			
03 03 L. Hog Creek – Ottawa River							
L. Hog Ck WWH)	3.62	4	12	5.5	21.5	32.8	substrate
03 06 Ottawa River							
Ottawa R (WWH)	43.45	11	10	4	25	21.9	channel
Ottawa R (WWH)	42.61	6	10	10	26	18.8	substrate
Ottawa R (WWH)	38.63	10	6.5	3	19.5	39.1	channel
Ottawa R (WWH)	37.91	8.5	11	4	23.5	26.6	substrate
Target (MWH)		**≥ 9**	**≥ 10**	**≥ 4**	**≥ 23**		
Target (WWH)		**≥ 13**	**≥ 14**	**≥ 5**	**≥ 32**		

Table 5-10. Characterization of the habitat TMDL using QHEI metrics for sites with impairment due to habitat alteration, sedimentation/siltation, turbidity, and/or flow alteration (non-natural) in the Little Hog Creek and Lima Reservoir-Ottawa River nested subwatersheds.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score QHEI	Sub-score High Influence	Sub-score Modified	Total Habitat Score
03 03 L. Hog Creek – Ottawa River								
L. Hog Ck (WWH)	3.62	45.5	1	6	0	1	0	1
03 06 Ottawa River								
Ottawa R (WWH)	43.45	49	1	5	0	0	0	0
Ottawa R (WWH)	42.61	58	2	8	0	0	0	0
Ottawa R (WWH)	38.63	48.5	2	8	0	0	0	0
Ottawa R (WWH)	37.91	63.5	1	6	1	1	0	2
Target (MWH)		**≥ 43 = 1 pt**	**< 2 = 1 pt**	**< 6 = 1 pt**				**3 pts**
Target (WWH)		**≥ 60 = 1 pt**	**< 2 = 1 pt**	**< 5 = 1 pt**				**3 pts**

Table 5-11. *E. coli* TMDL table: Ottawa R. @ Shawnee Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	4	4	1	0
Median Sample load	N/A	5279	1166.20	613.31	N/A
Total Load Reduction Required	No Data	**93.4%**	**83.6%**	No Data	**73.8%**
Total Maximum Daily Load	2866.00	654.64	275.78	238.45	224.54
Margin of Safety: 20%	573.20	130.93	55.16	47.69	44.91
Allowance for future growth: 2%	57.32	13.09	5.52	4.77	4.49
Load Allocation	1479.07	81.93	41.52	22.15	11.30
Wasteload Allocation Total	758.57	430.85	175.74	166.50	166.50
Lima MS4	346.94	19.21	9.73	0.00	0.00
County Line Invest. LLC 2PW00018	0.01	0.01	0.01	0.01	0.01
Ada WWTP 2PB00050	12.19	12.19	12.19	12.19	12.19
Colonial Golfer's Club 2PR00195	0.05	0.05	0.05	0.05	0.05
LaFayette WWTP 2PA00049	0.48	0.48	0.48	0.48	0.48
National Lime & Stone Co 2J00013	9.54	9.54	9.54	9.54	9.54
PCS Nitrogen 2IF00004	17.84	17.84	17.84	17.84	17.84
Lima Refinery 2IG00018	38.16	38.16	38.16	38.16	38.16
Lima WWTP 2PE00000	333.87	333.87	88.24	88.24	88.24

Values were adjusted for rounding.
*10% in Low flow regime

5.3 Lost Creek (04100007 03 05)

Total phosphorus reductions ranged from 0 percent to 82.4 percent in this nested subwatershed. *E. coli* reductions ranged from 62.8 percent to 98.5 percent.

Table 5-12. Total phosphorus TMDL table: Lost Ck @ Reservoir Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	2	3	0	0
Median Sample load	N/A	5	0.15	N/A	N/A
Total Load Reduction Required	No Data	**82.4%**	**NA**	No Data	No Data
Total Maximum Daily Load	10.09	0.88	0.24	0.07	0.02
Margin of Safety: 5%	0.50	0.04	0.01	0.003	0.001
Allowance for future growth: 2%	0.20	0.02	0.00	0.001	0.0004
Load Allocation	6.94	0.60	0.17	0.07	0.01
Wasteload Allocation Total	2.44	0.21	0.06	0.00	0.00
Lima MS4	2.44	0.21	0.06	0.00	0.00

Values were adjusted for rounding.

Table 5-13. *E. coli* TMDL table: Lost Creek @ E. High St.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	5	6	1	0
Median Sample load	N/A	419	18.15	1.87	N/A
Total Load Reduction Required	No Data	**98.5%**	**89.1%**	**62.8%**	No Data
Total Maximum Daily Load	102.44	8.17	2.53	0.89	0.18
Margin of Safety: 20%*	20.49	1.63	0.51	0.18	0.02
Allowance for future growth: 2%	2.05	0.16	0.05	0.02	0.00
Load Allocation	59.12	4.70	1.45	0.68	0.15
Wasteload Allocation Total	20.78	1.67	0.52	0.01	0.01
Lima MS4	20.77	1.65	0.51	0.00	0.00
County Line Invest. LLC 2PW00018	0.01	0.01	0.01	0.01	0.01

Values were adjusted for rounding.
*10% in Low flow regime

5.4 Little Ottawa River (04100007 04 01)

Total phosphorus reductions ranged from 57.8 percent to 60.1 percent in this nested subwatershed. *E. coli* reductions ranged from 0 percent to 97.4 percent. Additional TMDLs included sediment.

Indian Village Mobile Home Park is preparing to tie into existing sewers, so it was not given a wasteload allocation in Table 5-14.

Table 5-14. Total phosphorus TMDL table: Little Ottawa River @ Ft. Amanda Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	3	2	0	0
Median Sample load	N/A	2	1.72	N/A	N/A
Total Load Reduction Required	No Data	57.8%	60.1%	No Data	No Data
Total Maximum Daily Load	3.52	0.92	0.74	0.69	0.68
Margin of Safety: 5%	0.18	0.05	0.04	0.03	0.03
Allowance for future growth: 2%	0.07	0.02	0.01	0.01	0.01
Load Allocation	1.95	0.18	0.06	0.04	0.02
Wasteload Allocation Total	1.33	0.67	0.63	0.61	0.61
Lima MS4	0.72	0.07	0.02	0.00	0.00
Cridersville WWTP 2PB00048	0.61	0.61	0.61	0.61	0.61

Values were adjusted for rounding.

Table 5-15. Characterization of the sediment TMDL in the Little Ottawa River nested subwatershed.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Categories			Total Sediment Score	Deviation from Target (%)	Main Impairment Category
		Substrate	Channel	Riparian			
04 01 Little Ottawa River							
L. Ottawa R (WWH)	1.85	6.5	17	5.5	29	9.4	substrate
Target (MWH)		**≥ 9**	**≥ 10**	**≥ 4**	**≥ 23**		
Target (WWH)		**≥ 13**	**≥ 14**	**≥ 5**	**≥ 32**		

Table 5-16. *E. coli* TMDL table: Little Ottawa River @ Ft. Amanda Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	1	4	5	1	0
Median Sample load	7336	850	89.57	1.61	N/A
Total Load Reduction Required	96.9%	97.4%	89.4%	N/A	No Data
Total Maximum Daily Load	294.46	28.14	12.21	7.55	5.58
Margin of Safety: 20%*	58.89	5.63	2.44	1.51	0.56
Allowance for future growth: 2%	5.89	0.56	0.24	0.15	0.11
Load Allocation	164.11	12.47	3.39	1.02	0.03
Wasteload Allocation Total	65.57	9.49	6.13	4.88	4.88
Lima MS4	60.98	4.90	1.54	0.00	0.00
Cridersville WWTP 2PB00048	4.88	4.88	4.88	4.88	4.88

Values were adjusted for rounding.
*10% in Low flow regime

5.5 Dug Run-Ottawa River (04100007 04 02)

E. coli reductions ranged from 60.9 percent to 98.5 percent in this nested subwatershed.

Table 5-17. *E. coli* TMDL table: Ottawa R. @ Copus Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	3	5	0	1
Median Sample load	N/A	16933	504.95	N/A	415.25
Total Load Reduction Required	No Data	**96.8%**	**53.5%**	No Data	**54.5%**
Total Maximum Daily Load	3268.6	701.28	300.96	257.65	241.50
Margin of Safety: 20%*	653.72	140.26	60.19	51.53	24.15
Allowance for future growth: 2%	65.37	14.03	6.02	5.15	4.83
Load Allocation	1467.41	85.68	39.71	23.77	11.89
Wasteload Allocation Total	1082.10	461.32	195.04	177.19	177.19
Lima MS4	659.27	38.49	17.84	0.00	0.00
County Line Invest. LLC 2PW00018	0.01	0.01	0.01	0.01	0.01
Ada WWTP 2PB00050	12.19	12.19	12.19	12.19	12.19
Colonial Golfer's Club 2PR00195	0.05	0.05	0.05	0.05	0.05
LaFayette WWTP 2PA00049	0.48	0.48	0.48	0.48	0.48
National Lime & Stone Co 2IJ00013	9.54	9.54	9.54	9.54	9.54
PCS Nitrogen 2IF00004	17.84	17.84	17.84	17.84	17.84
Lima Refinery 2IG00018	38.16	38.16	38.16	38.16	38.16
Lima WWTP 2PE00000	333.87	333.87	88.24	88.24	88.24
Cridersville WWTP 2PB00048	4.88	4.88	4.88	4.88	4.88
Shawnee #2 WWTP 2PK00002	9.54	9.54	9.54	9.54	9.54

Values were adjusted for rounding.
*10% in Low flow regime

Table 5-18. *E. coli* TMDL table: Honey Run @ Wapak Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	1	4	5	0	0
Median Sample load	4547	960	29.95	N/A	N/A
Total Load Reduction Required	**96.0%**	**98.5%**	**85.2%**	No Data	No Data
Total Maximum Daily Load	230.58	18.37	5.67	1.97	0.40
Margin of Safety: 20%	46.12	3.67	1.13	0.39	0.08
Allowance for future growth: 2%	4.61	0.37	0.11	0.04	0.01
Load Allocation	179.86	14.33	4.42	1.54	0.31
Wasteload Allocation Total	0.00	0.00	0.00	0.00	0.00

Values were adjusted for rounding.

5.6 Honey Run (04100007 04 03) and Beaver Run-Ottawa River (04100007 04 06)

Total phosphorus reductions ranged from 0 percent to 72.6 percent in these nested subwatersheds. *E. coli* reductions ranged from 16.5 percent to 56.9 percent. Additional TMDLs included sediment and habitat.

Table 5-19. Total phosphorus TMDL table: Honey Run @ Cremeans Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	3	2	0	0
Median Sample load	N/A	19	0.51	N/A	N/A
Total Load Reduction Required	No Data	72.6%	N/A	No Data	No Data
Total Maximum Daily Load	19.55	1.66	0.42	0.11	0.02
Margin of Safety: 5%	0.98	0.08	0.02	0.01	0.001
Allowance for future growth: 2%	0.39	0.03	0.01	0.002	0.0005
Load Allocation	18.18	1.55	0.39	0.10	0.02
Wasteload Allocation Total	0.00	0.00	0.00	0.00	0.00

Values were adjusted for rounding.

Table 5-20. Characterization of the sediment TMDL in the Honey Run nested subwatershed.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Categories			Total Sediment Score	Deviation from Target (%)	Main Impairment Category
		Substrate	Channel	Riparian			
04 03 Ottawa River							
Honey Run (MWH-C)[1]	3.58	8.5	8	8.5	25	---	channel
Target (MWH)		≥ 9	≥ 10	≥ 4	≥ 23		
Target (WWH)		≥ 13	≥ 14	≥ 5	≥ 32		

[1] The site meets the overall sediment score; however, two of the sub-metrics do not meet the target and are considered to be influencing the attainment status.

Table 5-21. Characterization of the habitat TMDL using QHEI metrics for sites with impairment due to habitat alteration, sedimentation/siltation, turbidity, and/or flow alteration (non-natural) in the Honey Run nested subwatershed.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score			
					QHEI	High Influence	Modified	Total Habitat Score
04 03 Ottawa River								
Honey Run (MWH-C)	3.58	50.5	3	10	1	0	0	1
Target (MWH)		≥ 43 = 1 pt	< 2 = 1 pt	< 6 = 1 pt				3 pts
Target (WWH)		≥ 60 = 1 pt	< 2 = 1 pt	< 5 = 1 pt				3 pts

Table 5-22. *E. coli* TMDL table: Ottawa R. @ US-224.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	4	4	0	1
Median Sample load	N/A	11058	517.41	N/A	172.91
Total Load Reduction Required	No Data	**93.8%**	**47.5%**	No Data	N/A
Total Maximum Daily Load	5906.76	876.22	348.31	292.58	266.13
Margin of Safety: 20%*	1181.35	175.24	69.66	58.52	53.23
Allowance for future growth: 2%	118.14	17.52	6.97	5.85	5.32
Load Allocation	3414.12	197.29	61.06	30.96	10.35
Wasteload Allocation Total	1192.46	486.17	210.63	197.23	197.23
Lima MS4	749.59	43.31	13.40	0.00	0.00
County Line Invest. LLC 2PW00018	0.01	0.01	0.01	0.01	0.01
Ada WWTP 2PB00050	12.19	12.19	12.19	12.19	12.19
Colonial Golfer's Club 2PR00195	0.05	0.05	0.05	0.05	0.05
LaFayette WWTP 2PA00049	0.48	0.48	0.48	0.48	0.48
National Lime & Stone Co 2IJ00013	9.54	9.54	9.54	9.54	9.54
PCS Nitrogen 2IF00004	17.84	17.84	17.84	17.84	17.84
Lima Refinery 2IG00018	38.16	38.16	38.16	38.16	38.16
Lima WWTP 2PE00000	333.87	333.87	88.24	88.24	88.24
Shawnee #2 WWTP 2PK00002	9.54	9.54	9.54	9.54	9.54
Elida WWTP 2PB00046	2.38	2.38	2.38	2.38	2.38
American #2 WWTP 2PH00006	5.72	5.72	5.72	5.72	5.72
American Bath STP 2PH00007	7.15	7.15	7.15	7.15	7.15
National Lime & Stone Co Rimer 2IJ00053	4.77	4.77	4.77	4.77	4.77
Cridersville WWTP 2PB00048	4.88	4.88	4.88	4.88	4.88

Values were adjusted for rounding.
*10% in Low flow regime

5.7 Pike Run (04100007 04 04)

E. coli reductions ranged from 98.0 percent to 98.5 percent in this nested subwatershed.

Table 5-23. *E. coli* TMDL table Pike Run @ Lima-Gomer Rd.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	1	4	5	1	0
Median Sample load	10398	1026	597.41	547.61	N/A
Total Load Reduction Required	**98.2%**	**98.0%**	**98.1%**	**98.5%**	No Data
Total Maximum Daily Load	234.75	26.70	14.24	10.60	9.06
Margin of Safety: 20%*	46.95	5.34	2.85	2.12	0.91
Allowance for future growth: 2%	4.69	0.53	0.28	0.21	0.18
Load Allocation	121.40	9.43	2.73	1.12	0.82
Wasteload Allocation Total	61.70	11.39	8.38	7.15	7.15
Lima MS4	54.54	4.24	1.23	0.00	0.00
American Bath STP 2PH00007	7.15	7.15	7.15	7.15	7.15

Values were adjusted for rounding.
*10% in Low flow regime

5.8 Leatherwood Ditch (04100007 04 05)

E. coli reductions ranged from 83.1 percent to 87.8 percent in this nested subwatershed.

Table 5-24. *E. coli* TMDL table: Leatherwood Ditch @ Putnam CR-U.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	3	2	0	0
Median Sample load	N/A	72	30.60	N/A	N/A
Total Load Reduction Required	No Data	**83.1%**	**87.8%**	No Data	No Data
Total Maximum Daily Load	194.21	15.48	4.78	1.66	0.34
Margin of Safety: 20%	38.84	3.10	0.96	0.33	0.07
Allowance for future growth: 2%	3.88	0.31	0.10	0.03	0.01
Load Allocation	151.48	12.07	3.73	1.30	0.26
Wasteload Allocation Total	0.00	0.00	0.00	0.00	0.00

Values were adjusted for rounding.

5.9 Sugar Creek (05 01)

E. coli reductions ranged from 90.8 percent to 92.8 percent in this nested subwatershed.

Table 5-25. *E. coli* TMDL table: Sugar Creek @ CR-O.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	6	2	0	1
Median Sample load	N/A	982	235.36	N/A	19.60
Total Load Reduction Required	No Data	**92.8%**	**90.8%**	No Data	**91.6%**
Total Maximum Daily Load	1135.60	90.45	27.90	9.62	1.88
Margin of Safety: 20%	227.12	18.09	5.58	1.92	0.38
Allowance for future growth: 2%	22.71	1.81	0.56	0.19	0.04
Load Allocation	868.05	69.14	21.33	7.50	1.46
Wasteload Allocation Total	17.72	1.41	0.44	0.00	0.00
Lima MS4	17.72	1.41	0.44	0.00	0.00

Values were adjusted for rounding.

5.10 Plum Creek (05 02)

Total phosphorus reductions ranged from 24.5 percent to 25.4 percent in this nested subwatershed. *E. coli* reductions ranged from 55.0 percent to 98.7 percent. Additional TMDLs included sediment and habitat.

Table 5-26. Total phosphorus TMDL table: Plum Creek @ TR-O.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	2	3	0	0
Median Sample load	N/A	17	6.87	N/A	N/A
Total Load Reduction Required	No Data	**24.5%**	**25.4%**	No Data	No Data
Total Maximum Daily Load	132.54	13.70	5.51	3.29	2.65
Margin of Safety: 5%	6.63	0.69	0.28	0.16	0.13
Allowance for future growth: 2%	2.65	0.27	0.11	0.07	0.05
Load Allocation	120.79	10.27	0.50	0.10	0.010
Wasteload Allocation Total	2.47	2.47	4.62	2.96	2.46
Columbus Grove WWTP 2PC00004	2.16	2.16	2.16	2.16	2.16
Columbus Grove CSOs	0.00	0.00	0.00	0.00	0.00
Cairo Sulfur Products 2IF00008	0.30	0.30	0.30	0.30	0.30

Values were adjusted for rounding.

Table 5-27. Characterization of the sediment TMDL in the Plum Creek nested subwatershed.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Categories			Total Sediment Score	Deviation from Target (%)	Main Impairment Category
		Substrate	Channel	Riparian			
05 02 Plum Ck – Ottawa River							
Plum Creek (MWH-C)	8.12	5	7.5	4	16.5	28.3	substrate
Target (MWH)		**≥ 9**	**≥ 10**	**≥ 4**	**≥ 23**		
Target (WWH)		**≥ 13**	**≥ 14**	**≥ 5**	**≥ 32**		

Table 5-28. Characterization of the habitat TMDL using QHEI metrics for sites with impairment due to habitat alteration, sedimentation/siltation, turbidity, and/or flow alteration (non-natural) in the Plum Creek nested subwatershed.
Note: ALU designation in parentheses.

Stream/River	River Mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	Sub-score			Total Habitat Score
					QHEI	High Influence	Modified	
05 02 Plum Creek – Ottawa River								
Plum Creek (MWH-C)	8.1	36	2	10	0	0	0	0
Target (MWH)		**≥ 43 = 1 pt**	**< 2 = 1 pt**	**< 6 = 1 pt**				**3 pts**
Target (WWH)		**≥ 60 = 1 pt**	**< 2 = 1 pt**	**< 5 = 1 pt**				**3 pts**

Table 5-29. *E. coli* TMDL table: Plum Creek @ SR-114.

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	0	5	6	1	0
Median Sample load	N/A	3720	112.33	19.99	N/A
Total Load Reduction Required	No Data	**98.7%**	**84.1%**	**55.0%**	No Data
Total Maximum Daily Load	710.22	61.68	22.87	11.53	6.72
Margin of Safety: 20%*	142.04	12.34	4.57	2.31	0.67
Allowance for future growth: 2%	14.20	1.23	0.46	0.23	0.13
Load Allocation	549.68	43.82	13.55	4.70	1.62
Wasteload Allocation Total	4.29	4.29	4.29	4.29	4.29
Columbus Grove WWTP 2PC00004	3.91	3.91	3.91	3.91	3.91
Cairo Sulfur Products 2IF00008	0.38	0.38	0.38	0.38	0.38

Values were adjusted for rounding.
*10% in Low flow regime

6 WATER QUALITY IMPROVEMENT STRATEGY

Based on the 2010 survey, where aquatic life use impairment was documented upstream from the city of Lima (primarily Hog and Little Hog creeks), it was primarily caused by nutrients, sediment and habitat alteration from cultivated crop land uses. Impairment in and around the city of Lima (the Ottawa River mainstem, the Little Ottawa River, Zurmehly Creek and an unnamed tributary to Lost Creek) was primarily caused by organic enrichment, nutrients, low dissolved oxygen and flow alteration stemming from municipal and industrial point sources, combined sewer overflows (CSOs), sanitary sewer overflows (SSOs) and dams. Aquatic life impairment downstream from the city of Lima (including Honey Run and Plum Creek) was generally caused by nutrients, organic enrichment and sediment stemming from cultivated crop land uses, CSOs and municipal point source discharges.

Table 6-1 shows an overview of all of the nested subwatersheds that contain sites with partial and non-attainment of aquatic life and recreation uses. Causes of impairment are shown within parentheses following each source that might contribute to that cause. Tables 6-6 through 6-8 each represent a separate subwatershed (see Figure 3-1 for a map). For each nested subwatershed, specific actions are recommended.

Recommendations were developed by Ohio EPA in consultation with local technical stakeholders. In each case, these actions are intended to be inclusive of possible methods to improve water quality in the watershed based on identified causes and sources of impairment. Because Ohio EPA recognizes that actions taken in any individual subwatershed may depend on a number of factors (including socioeconomic, political and ecological factors), these recommendations are not intended to be prescriptive of actions to be taken, and any number or combination might contribute to improvement, whether applied at sites where actual impairment was noted or other locations where sources contribute indirectly to water quality impairment. Further details about individual practices can be found in Appendix E.

Table 6-1. Categories of implementation actions recommended in the Ottawa River (Lima area) watershed.

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories**											
	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
Upper Ottawa River (04100007 03)												
Middle Hog Creek (03 02)												
CAFO (bacteria)									x	H		
Unknown source (bacteria)	Not applicable											
Municipal point source discharge - Ada (bacteria)												x
Little Hog Creek (03 03)												
Streambank modifications and destabilization (TSS, sedimentation/ siltation, habitat alterations)	L			M					x	H		
Loss of riparian habitat (habitat alterations)	L			M					x	H		
Crop production with subsurface drainage (nutrients, TSS)				L					x	H		
Failing HSTS (low DO, organic enrichment, nutrients, bacteria)								x	x			
Municipal point source discharge - Lafayette (bacteria)												x
Lower Hog Creek (03 04)												
Crop production with subsurface drainage (nutrients, sedimentation/ siltation)				L					x	H		
Unknown source (bacteria)	Not applicable											
Lost Creek (03 05)												
Urban runoff/storm sewers (organic enrichment, nutrients)									x		H	x
Other spill related impacts (fish kills)												x
SSOs in Lima (bacteria)												x
Lima Reservoir-Ottawa River (03 06)												

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories** Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
Dam or impoundment (DO (low, range), low flow alterations, nutrients, habitat alterations, organic enrichment, nutrient/ eut. bio. indic.)					R (low)							
Flow alterations from water diversions (low flow alterations)									x			
Crop production with subsurface drainage (nutrients, DO (low, range), nutrient/ eut. bio. indic., low flow alterations)									x	H		
Municipal point source discharge (nutrients, ammonia, nutrient/ eut. bio. indic.)												x
Industrial point source discharge (nutrients, DO (range), ammonia, chronic toxicity (unknown), nutrient/ eut. bio. ind.)												x
Urban runoff/storm sewers (nutrients, sedimentation/ siltation)									x		H	
CSOs (DO (low, range), organic enrichment, nutrients, ammonia, nutrient/ eut. bio. indic., bacteria)												x
Historic bottom deposits (anthropogenic substrate alterations)	No action recommended											
Unknown source (unknown[1], bacteria)	Not applicable											
Middle Ottawa River (04100007 04)												
Little Ottawa River (04 01)												
Unspecified domestic waste (organic enrichment, BOD, nutrients, bacteria)	A small train derailed and damaged a sewer pipe; the problem has been resolved.											
Package plant (organic enrichment, BOD, nutrients, bacteria)												x
Urban runoff/storm sewers (nutrients, organic enrichment, bacteria)											x	

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories**											
	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
Municipal point source discharges (nutrients, organic enrichment, bacteria)												x
SSOs (nutrients, organic enrichment, bacteria)												x
Failing HSTS (nutrients, organic enrichment, bacteria)								x	x			
Channelization (habitat alterations)	L			M								
Dug Run-Ottawa River (04 02)												
Municipal point source discharges (nutrients, organic enrichment, low DO, bacteria, nutrient/eut. bio. indic.)												x
Industrial point source discharge (nutrients, nutrient/eut. bio. indic.)											x	x
SSOs (nutrients, organic enrichment, DO (low, range), bacteria, nutrient/eut. bio. indic.)												x
Urban runoff/storm sewers (organic enrichment, nutrient/eut. bio. indic.)											x	
Dam or impoundment (fish passage barrier)					R							
Unknown source (unknown)[1]	Not applicable											
Failing HSTS (bacteria)								x	x			
Honey Run (04 03)												
Crop production with subsurface drainage (low DO, nutrients)				M					x	H		
Channelization (habitat alterations)	M			M					x	H		
Unknown source (bacteria)	Not applicable											
Pike Run (04 04)												
Unsewered community - Gomer (bacteria)								x	x			x
Leatherwood Ditch (04 05)												
Failing HSTS (bacteria)								x	x			

Location Description (10-digit HUC) **Location Description (12-digit HUC)** **Sources (Causes)**	**Restoration Categories**											
	Bank & Riparian Restoration	Stream Restoration	Wetland Restoration	Conservation Easements	Dam Modification or Removal	Levee or Dike Modification or Removal	Abandoned Mine Land Reclamation	Home Sewage Planning and Improvement	Education and Outreach	Agricultural Best Management Practices	Storm Water Best Management Practices	Regulatory Point Source Controls
CAFO (bacteria)									x	H		
Beaver Run-Ottawa River (04 06)												
Unsewered community - Rimer (bacteria)								x	x			
Unknown source (bacteria)	Not applicable											
Lower Ottawa River (04100007 05)												
Sugar Creek (05 01)[2]												
Unsewered community - Vaughnsville (bacteria)								x	x			
Plum Creek (05 02)												
CSOs (organic enrichment, fish kills, unknown[3], ammonia, CBOD, nutrients, low DO)												x
Municipal point source discharges (ammonia, CBOD, nutrients, low DO, nutrient/eut. bio. indic., bacteria)												x
Crop production with subsurface drainage (nutrients, low DO, nutrient/eut. bio. indic.)				L					x	H		
Channelization (sedimentation/siltation)	L			M					x	H		
Village of Kalida-Ottawa River (05 03)												
Unknown source (bacteria)	Not applicable											

1 Probable causes are pollutants related to legacy urban sources.
2 The 2014 Integrated Report will reflect a change to full support of the aquatic life use.
3 Refers to toxicity.

6.1 Regulatory Recommendations

Recommendations for NPDES permits are summarized by discharger and nested subwatershed in Tables 6-2 and 6-3. Table 6-4 shows wasteload allocations for the city of Lima MS4. Any suggestions in permit limits reflect calculated TMDLs. Ohio EPA will work with permit holders to accomplish any needed reductions in loadings.

The Lima Refining Company is currently discussing alternative methods for handling its effluent. One option the company is considering is the reduction or removal of its discharge from the Ottawa River. Because the load from the Lima Refining Company is so much smaller than the load from the Lima WWTP, its withdrawal will not substantially affect the nutrient modeling and therefore will not require a recalculation of the TMDL.

Table 6-2. Recommended implementation actions through the NPDES program for total phosphorus.
Note: Any specific permit condition noted in the table indicates a recommended change from current permit conditions. "No change" means that no change is recommended.

Nested Sub-watershed (04100007)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow (million gallons per day)	Wasteload Allocation (load in kg/day)	Wasteload Allocation (concen-tration in mg/l)	Recommended Permit Conditions – Phase: 1st	2nd	3rd	4th	Explanation for difference
03 02	Ada WWTP[1]	2PB00050	Hog Creek	2.00	0.85	0.84	Average monthly limit of 1.0 mg/l	Re-sample	Average monthly limit of 0.84 mg/l	No change	Since Ada is building a new facility and a limit of 1.0 mg/l will be implemented when the new facility is finished, it is likely that the limit of 1.0 mg/l will be sufficient to attain WQS.
03 06	National Lime and Stone	2IJ00013	Ottawa River	2.00	0.11	0.015	No change	No change	No change	No change	A nominal load was included because of the potential that the discharge might be influenced by runoff into the quarry, but no permit changes are anticipated.
03 06	Lima WWTP	2PE00000	Ottawa River	18.50	5.33	0.076	No change	Average monthly limit of 0.5 mg/l	No change	Average monthly limit of 0.08 mg/l	There is some uncertainty as to how CSO improvements will affect the stream's biological attainment. The delay in permit change will allow Ohio EPA to gauge improvement based on CSO changes.
03 06	Lima Refining Company	2IG00001	Ottawa River	5.49	1.58	0.0762	No change	Average monthly limit of 0.7 mg/l	Average monthly limit of 0.5 mg/l	Average monthly limit of 0.08 mg/l	There is some uncertainty as to how CSO improvements will affect the stream's biological attainment. The delay in permit change will allow Ohio EPA to gauge improvement based on CSO changes.

Nested Sub-watershed (04100007)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow (million gallons per day)	Wasteload Allocation (load in kg/day)	Wasteload Allocation (concen-tration in mg/l)	Recommended Permit Conditions Phase 1st	2nd	3rd	4th	Explanation for difference
03 06	PCS Nitrogen	2IF00004	Ottawa River	3.74	1.25	0.0762	Average monthly limit of 1.0 mg/l	No change	Average monthly limit of 0.5 mg/l	Average monthly limit of 0.08 mg/l	There is some uncertainty as to how CSO improvements will affect the stream's biological attainment. The delay in lower limits will allow Ohio EPA to gauge improvement based on CSO changes.
04 01	Cridersville WWTP	2PB00048	Little Ottawa River	0.80	0.61	0.57	Monitor 2 x / month	Average monthly limit of 1.0 mg/l	Average monthly limit of 0.57 mg/l	No change	Currently there is no limit at the facility and monitoring is monthly. An increase in monitoring will confirm the need for a limit of 1.0 mg/l, will be a significant reduction. This plan will allow re-sampling between phases prior to incurring significant upgrade costs.
04 02	Shawnee #2 WWTP	2PK00002	Ottawa River	2.00	2.31	0.305	No change	No change	Average monthly limit of 0.5 mg/l	Average monthly limit of 0.31 mg/l	There is some uncertainty as to how CSO improvements will affect the stream's biological attainment. The delay in permit change will allow Ohio EPA to gauge improvement based on CSO changes.
05 02	Columbus Grove WWTP	2PC00004	Plum Creek	0.82	2.16	1.2	No change	Average monthly limit of 1.2 mg/l	No change	No change	Delaying a permit limit at the facility will allow time for LTCP implementation, which may improve biology sufficiently to not implement the TMDL limit.
05 02	Cairo Sulfur Products	2IF00008	Plum Creek	0.08	0.30	1.0	No change	No change	No change	No change	Cairo Sulfur Products is already meeting its WLA.

[1] Ada is upgrading its WWTP and information listed in this table is based on the planned upgrade.

The Indian Village Mobile Home Park will tie into Shawnee WWTP in the near future, so it is receiving no wasteload allocation.

Table 6-3. Recommended implementation actions through the NPDES program for *E. coli*.

Nested Sub-watershed (04100007)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow (million gallons per day)	Wasteload Allocation (load in millions cfu/day)[1]	Wasteload Allocation (concen-tration in cfu / 100 ml)[1]	Recommended Permit Conditions
03 02	Ada WWTP[2]	2PB00050	Hog Creek	2.00	12.19	161	Average monthly limit of 161 cfu/100 ml
03 03	Colonial Golfer's Club	2PR00195	Unnamed tributary to Little Hog Creek	0.0075	0.05	161	Average monthly limit of 161 cfu/100 ml
03 03	Lafayette WWTP	2PA00049	Little Hog Creek	0.10	0.48	126	Average monthly limit of 126 cfu/100 ml
03 05	County Line Investment LLC	2PW00018	Unnamed tributary to Lost Creek	0.0030	0.01	126	Average monthly limit of 126 cfu/100 ml
03 06	Lima Refining Company	2IG00001	Ottawa River	5.49	38.16	126	Average monthly limit of 126 cfu/100 ml
03 06	Lima WWTP	2PE00000	Ottawa River	18.50	333.87	126	Average monthly limit of 126 cfu/100 ml
03 06	National Lime and Stone	2IJ00013	Ottawa River	2.00	9.54	126	No change. Any bacteria discharged from the quarry is incidental from runoff, so the permit will not be changed.
03 06	PCS Nitrogen	2IF00004	Ottawa River	3.74	17.84	126	Average monthly limit of 126 cfu/100 ml
04 01	Cridersville WWTP	2PB00048	Unnamed tributary to Little Ottawa River	0.80	4.88	161	Average monthly limit of 161 cfu/100 ml
04 02	American #2 WWTP	2PH00006	Dug Run	1.20	5.72	126	Average monthly limit of 126 cfu/100 ml
04 02	Elida STP	2PB00046	Ottawa River	0.50	2.38	126	Average monthly limit of 126 cfu/100 ml
04 02	Shawnee #2 WWTP	2PK00002	Ottawa River	2.00	9.54	126	Average monthly limit of 126 cfu/100 ml
04 04	American Bath STP	2PH00007	Pike Run	1.50	7.15	126	Average monthly limit of 126 cfu/100 ml
04 06	National Lime and Stone Rimer	2IJ00053	Ottawa River	1.00	4.77	126	No change. Any bacteria discharged from the quarry is incidental from runoff, so the permit will not be changed.
05 02	Cairo Sulfur	2IF00008	Plum Creek	0.08	0.38	126	Average monthly limit of 126

Nested Sub-watershed (04100007)	Entity	Ohio EPA Permit #	Receiving Stream	Design Flow (million gallons per day)	Wasteload Allocation (load in millions cfu/day)[1]	Wasteload Allocation (concen-tration in cfu / 100 ml)[1]	Recommended Permit Conditions
	Products						cfu/100 ml
05 02	Columbus Grove WWTP	2PC00004	Plum Creek	0.82	3.91	126	Average monthly limit of 126 cfu/100 ml

[1] "cfu" stands for colony-forming units.
[2] Ada is upgrading its WWTP and information listed in this table is based on the planned upgrade.

The Indian Village Mobile Home Park will tie into Shawnee WWTP in the near future, so it is receiving no wasteload allocation.

Table 6-4. Wasteload allocations for the Lima municipal separate storm sewer system (MS4; permit no. 2GQ00021).

Parameter (unit)	Flow Regime	Zurmehly Creek	Lost Creek	Little Ottawa River	Ottawa River	Pike Run	Sugar Creek
Total phosphorus (in kg/day)	High flows Wet weather flows Normal flows	2.30 0.20 0.05	2.44 0.21 0.06	0.72 0.07 0.02	N/A	N/A	N/A
E. coli (in millions cfu / day)	High flows Wet weather flows Normal flows	20.77 1.65 0.51	20.77 1.65 0.51	60.98 4.90 1.54	749.59 43.31 13.40	54.24 4.24 1.23	17.72 1.41 0.44

A TMDL was calculated for carbonaceous biochemical oxygen demand to address organic enrichment on the Ottawa River in the city of Lima. However, since the only recommended permit change is implementing a long-term control plan once it is finalized, a table is not included in this section.

Lima WWTP CSO Conditions

The NPDES permit for the Lima WWTP was renewed in January 2013. Part I, C (Schedules) contains multiple actions to address SSO and CSO issues in Lima. The schedule is included below.

1. Construction Schedule for Wet Weather Improvements - Specific Projects to be Implemented according to Items a. through i. below
   a. Collett Street Sewer Lining

   i. Commence construction as soon as possible, but no later than 9 months from the effective date of this permit. (Event Code 03099)
   ii. Complete construction as soon as possible, but no later than 12 months from the effective date of this permit. (Event Code 04599)
   iii. Notify Ohio EPA, Northwest District Office, Division of Surface Water within 7 days of completing construction.

b. Time-critical Lift Station Projects - These include the Allentown Road Pump Station, Cable Road Pump Station, Gloria Avenue Pump Station, Lost Creek Pump Station, Hickory Knoll Pump Station and the Sugar Street Pump Station.
   i. Submit a permit-to-install application and detail plans as soon as possible, but no later than 6 months from the effective date of this permit. (Event Code 01299)
   ii. Advertise for construction bids, receive bids, and award contracts as soon as possible, but not later than 9 months from the effective date of this permit. (Event Code 01899)
   iii. Commence construction as soon as possible, but no later than 14 months from the effective date of this permit. (Event Code 03099)
   iv. Complete construction as soon as possible, but no later than 24 months from the effective date of this permit. (Event Code 04599)
   v. Notify Ohio EPA, Northwest District Office, Division of Surface Water within 7 days of completing construction.

c. Baxter Street Interceptor Work
   i. (was a PTI submittal requirement – already done)
   ii. Advertise for construction bids, receive bids, and award contracts as soon as possible, but not later than 4 months from the effective date of this permit. (Event Code 01899)
   iii. Submit a status report on awarding construction contracts as soon as possible, but not later than 16 months from the effective date of this permit. [Event Code 95999].
   iv. Commence construction as soon as possible, but no later than 21 months from the effective date of this permit. (Event Code 03099)
   v. Complete construction as soon as possible, but no later than 33 months from the effective date of this permit.
   vi. Notify Ohio EPA, Northwest District Office, Division of Surface Water within 7 days of completing construction.

d. Headworks and Primary Clarification Improvements:
   These improvements shall also include piping and pumps, modifications/expansions and upgrades to the existing disinfection system; the improvements shall be designed to achieve secondary treatment at Outfall 001 for 70 MGD, once regulatory approval is received by the City to operate in Peak Wet Weather mode.
   i. Submit status report on the PTI application and detail plans as soon as possible, but no later than 10 months from the effective date of this permit. [Event Code 95999]
   ii. Submit a permit-to-install application and detail plans as soon as possible, but no later than 19 months from the effective date of this permit. (Event Code 01299)
   iii. Submit a status report on construction contracts as soon as possible, but not later than 30 months from the effective date of this permit.

iv. Advertise for construction bids, receive bids, and award contracts as soon as possible, but not later than 36 months from the effective date of this permit.
v. Commence construction as soon as possible, but no later than 42 months from the effective date of this permit.
vi. No later than 54 months from the effective date of this permit, submit a status report to Ohio EPA, Northwest District Office, Division of Surface Water on construction progress and ability to meet final compliance date.
vii. Complete construction as soon as possible, but no later than 66 months from the effective date of this permit.
viii. Notify Ohio EPA, Northwest District Office, Division of Surface Water within 7 days of completing construction.

6.2 Mainstem Implementation Phases

Causes of impairment in the Ottawa River are numerous. These causes clearly act together to stress the aquatic life in the stream. Meeting biological water quality standards in the impaired section (RM 28.9 – 43.4) of the Ottawa River will require a major commitment from local stakeholders. Several modeling techniques are used to determine TMDLs for different pollutants that are identified as stressors to the stream system. These modeling techniques are not interactive and several focus on a specific critical condition (*i.e.*, QUAL2K nutrients and CSO model). The interactions between these conditions are difficult to represent in a model; therefore, it is not known exactly how changes in one critical condition will affect the aquatic life in a different critical condition. One of the most plaguing stressors in the system is nutrient enrichment, which is exacerbated at low flows when point sources have the ability to dominate the system. Modeling results predict that to meet nutrient water quality targets substantial measures would have to be taken to reduce point source loads of phosphorus.

However when considering nutrient targets Ohio EPA has issued guidance (2000) for how flexibility in nutrient targets can be addressed:

> *"Intermediate nutrient targets are available to complement the biological criteria and to help evaluate the impact of nutrient loadings. These target concentrations are identified in a technical report (Ohio EPA 1999). The values in the technical report represent 'no affect or no impact' based concentrations that have been associated with measured biological criteria and aquatic life use attainment. In most situations, higher concentrations can reasonably be expected to carry an increasing risk of impaired biological communities and failure to attain the respective aquatic life use. However, the values in the technical report are only suggested guidelines, and a variety of factors must be considered in selecting a specific nutrient target used in the TMDL process. These factors include:*
>
> > *<u>Some waters attain aquatic life criteria at higher concentrations</u> – this fact is evident in the technical report (Ohio EPA 1999) and requires that a variety of physical and hydrological factors be evaluated on a case-by-case basis prior to setting a target level.*
> >
> > *<u>Location of project with respect to ecoregion</u> – consult the technical report (Ohio EPA 1999) and assess if higher or lower targets may be appropriate.*
> >
> > *<u>Stream habitat condition</u> – unusually low or high physical habitat quality will influence nutrient impacts on aquatic life; adjust the targets accordingly.*
> >
> > *<u>Streamflow conditions</u> – impairment of the aquatic life use caused by nutrients is exacerbated on wastewater effluent dominated streams (high percentage of wastewater during low flow periods).*
>
> *Because the values in the technical report are initial target concentrations only and are not codified in regulations, there is a certain degree of flexibility as to how they can be used in a TMDL setting. A TMDL must be flexible in its consideration of load reduction, habitat improvements, the degree of wastewater effluent flow predominance, and other features that determine attainment of biological criteria. As provided in paragraph (E) of rule 3745-2-12, TMDL nutrient targets may allow for a phased reduction towards the selected target in recognition of such factors as habitat restoration efforts, technical feasibility, treatment costs,*

and the possibility of achieving aquatic life use attainment at concentrations in excess of the target value."

In the Ottawa River, flexibility will be exercised. The possibility of the stream supporting its designated aquatic life use at higher nutrient levels is supported by the reach immediately downstream from the modeled reach. In this reach nutrient levels remain elevated but aquatic life is in full attainment of its designated use. Interactions between causes of impairment are also not readily represented in the modeling techniques used to develop TMDLs. Therefore, implementation phases are proposed where all causes are gradually mitigated until biological life attainment is observed. If biological attainment is achieved before the final implementation phase, the nutrient TMDL can be recalculated. Allocations will be adjusted to represent the condition where biological life standards are achieved in the stream. If biological life standards are achieved before complete implementation of the CSO LTCP, the TMDL will not be recalculated because impairments are not only linked to biological life, but also to recreation use.

The QUAL2K model was used to present the predicted impacts on in-stream water quality. Certain variables can be adjusted in the model representing different phases of implementation. The two that were focused on are removal of lowhead dams and different discharge concentrations for point source discharges. One option that was not considered as a variable is CSO discharges. These scenarios are built on the assumption that CSO impact is difficult to predict and mitigation of CSOs are a large part of what is needed to achieve attainment in the river. CSOs do not directly impact the stream at the same critical condition that is used to assess nutrient loads, meaning CSOs do not discharge during the 7Q10 low flow critical condition; however, their impacts do linger as increased sediment oxygen demand. The QUAL2K model does not adequately address these impacts, which limits its effectiveness and encourages a flexible implementation approach.

Implementation Phases

Phases are chosen based on the potential of improving water quality of the Ottawa River by taking phases that methodically reduce pollutant loads or other stresses. The QUAL2K model was used to demonstrate the impact each phase will have on nutrient enrichment in the Ottawa River.

Phase 1:
In this phase it is expected that the CSO long term control plan (LTCP) will have been adopted for the city of Lima and resulting compliance schedules are met. The Lima WWTP is the only major discharger in the modeled reach that currently has a permit limit for total phosphorus. The first phase recommends the institution of a regulatory framework to limit the discharge of phosphorus to the Ottawa River. All major dischargers to the Ottawa River receive a wasteload allocation that is equal to the facilities' design (municipal WWTP) or average (industrial) flows and a concentration of 1.0 mg/l total phosphorus. A minor reduction from existing loads during critical condition is expected in this phase because PCS Nitrogen will reduce its total phosphorus permit limit to 1.0 mg/l from an average discharge of 1.5 mg/l.

Phase 2:
The second phase assumes that the Ottawa River is still impaired by nutrients after the implementation of the first phase and with progression of the LTCP implementation. In this phase the point source discharges of phosphorus will be further limited at two facilities if attainment of biological criteria has not been documented. If the discharger currently has the

potential to discharge at or above 1.0 mg/l at low flows, the limit in this phase stays at 1.0 mg/l total phosphorus. If the point source has the potential with current technology to discharge at levels below 1.0 mg/l total phosphorus, the wasteload allocation is limited to that value. Nutrients as addressed by the TMDL are treated as chronic pollutants (not acutely toxic) and limits are proposed as chronic pollutant limits (Table 6-5).

Table 6-5. Proposed total phosphorus limits for major NPDES facilities for the second implementation phase via the QUAL2K model.

Facility	Design Flow (MGD)	Total Phosphorus Concentration (mg/l)
Lima WWTP (2PE00000)	18.50	0.500
Lima Refinery (2IG00001)	5.49	0.700
PCS Nitrogen (2IF00004)	3.74	1.000
Shawnee #2 WWTP (2PK00002)	2.00	1.000

Also, while not a traditional pollutant, a study shows lowhead dams have a major impact on the stream environment (Santucci *et al.* 2005). The study identifies how physical channel alteration affects certain aquatic species disproportionately. The result is algal growth that is unchecked by typical macroinvertebrate grazing, which fuels the food chain for insectivorous fishes. The result is the effects of nutrient enrichment being exacerbated in dam pools. Reaches of the river impacted by the lowhead dams are also indicated as being impacted by nutrient enrichment. Dam removal causes two changes that reduce the impact of nutrients at low flows:

1) Nutrient retention from flow regimes outside the critical condition is reduced.
2) Reduction in travel time through the reach decreases production of phytoplankton in the reach.

Based on these observations two dams are recommended to be removed in the second implementation phase to reduce the impact of nutrient enrichment in the Ottawa River. The two dams that are recommended to be removed are the Fetter Road dam and the Erie Railroad (RR) dam near the Lima WWTP. The Erie RR dam is thought to be interactive with the City's CSOs by exacerbating their impacts during the low flow critical condition. Additional stress would be alleviated on certain parts of the aquatic community because lotic conditions will be restored in the old dam impoundment.

Phase 3:
The nature of a LTCP for mitigating CSO impacts to a stream is that the implementation takes place in multiple phases over an extended timeframe. Biology will again be reassessed and impacts associated with the CSOs should be reduced. At this point the impact of nutrient enrichment in the low flow critical condition should become more pronounced. If nutrient impacts to aquatic life are still determined to be a cause of impairment downstream from point sources, it will be necessary to take steps to reduce the nutrient loads from the point sources. Generally Ohio EPA does not allocate loads to point sources based on effluent total phosphorus concentration of lower than 0.5 mg/l (Ohio EPA 2000). However, case-by-case evaluation of loads can allow for lower limits, if necessary to alleviate nuisance conditions, justifying the next implementation phase. In the third implementation phase, the four major point sources are allocated based on effluent total phosphorus concentrations of 0.5 mg/l.

Also recommended with the phased approach to implementation is an additional dam removal. In this phase, the Baxter Street dam is recommended to be removed. The Baxter Street dam is again interactive with the CSO discharges in the city of Lima and its removal will add to water quality improvements upstream from the major point source discharges.

Phase 4:
The final implementation phase is intended for the situation in which, even after complete implementation of the LTCP for the city of Lima CSOs and a modest lowering of nutrient limits, biological life is still observed to be impaired in the Ottawa River by nutrient enrichment. The TMDL scenario where the water quality target is met is implemented. This scenario was developed earlier in the appendix but is again presented to show the progression of nutrient reduction to achieve biological life water quality standards.

6.3 Upper Ottawa River (04100007 03)

Aquatic life use impairments in this subwatershed are primarily on the mainstem of the Ottawa River, caused by nutrients and organic enrichment from CSOs and point source discharges. The nutrient and enrichment issues are exacerbated by flow alterations from a series of dams on the mainstem beginning just upstream from the City and continuing until the Allentown dam just downstream from the City. For specific recommendations to phase in implementation for this portion of the river, please see Section 6.2. Impairments on Hog and Little Hog creeks step from issues related to cultivated cropland, so recommendations focus on agricultural best management practices (BMPs).

Table 6-6. Recommended implementation actions in the Upper Ottawa River subwatershed.

Restoration Categories		**Specific Restoration Actions**	**Upper Ottawa River (04100007 03)**				
			Middle Hog Creek (03 02)	Little Hog Creek (03 03)	Lower Hog Creek (03 04)	Lost Creek (03 05)	Lima Reservoir-Ottawa River (03 06)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering		x			
		Restore streambank by recontouring or regrading		x			
	planted	Plant grasses in riparian areas		x			
		Plant prairie grasses in riparian areas		x			
		Remove/treat invasive species					
		Plant trees or shrubs in riparian areas		x			
Stream Restoration		Restore flood plain					
		Restore stream channel					
		Install in-stream habitat structures					
		Install grade structures					
		Construct 2-stage channel					
		Restore natural flow					
Wetland Restoration		Reconnect wetland to stream					

Restoration Categories		Specific Restoration Actions	Upper Ottawa River (04100007 03)				
			Middle Hog Creek (03 02)	Little Hog Creek (03 03)	Lower Hog Creek (03 04)	Lost Creek (03 05)	Lima Reservoir-Ottawa River (03 06)
		Reconstruct & restore wetlands					
		Plant wetland species					
Conservation Easements		Acquire conservation easements		x	x		
Dam Modification or Removal		Remove dams					R
		Modify dams					
		Remove associated dam support structures					
		Install fish passage and/or habitat structures					
		Restore natural flow					x
Levee or Dike Modification or Removal		Remove levees					
		Breach or modify levees					
		Remove dikes					
		Modify dikes					
		Restore natural flood plain function					
Abandoned Mine Land Reclamation	treatment	Construct lime dosers					
		Install slag leach beds					
		Install limestone leach beds					
		Install limestone channels					
		Install successive alkalinity producing systems					
		Install settling ponds					
		Install vertical flow ponds					
		Install limestone drains (anoxic and/or oxic)					
		Construct acid mine drainage wetland					
	flow diversion	Repair subsidence sites					
		Reclaim pit impoundments					
		Reclaim abandoned mine land					
		Eliminate stream captures					
		Eliminate mine drainage discharges					
		Restore positive drainage					
		Cover toxic mine spoils					
Home Sewage Planning and Improvement		Develop HSTS plan		x			
		Inspect HSTS		x			
		Repair or replace traditional HSTS		x			
		Repair or replace alternative HSTS		x			

Restoration Categories		Specific Restoration Actions	Upper Ottawa River (04100007 03)				
			Middle Hog Creek (03 02)	Little Hog Creek (03 03)	Lower Hog Creek (03 04)	Lost Creek (03 05)	Lima Reservoir-Ottawa River (03 06)
Education and Outreach		Host meetings, workshops, and/or other events	x	x	x	x	x
Education and Outreach		Distribute educational materials	x	x	x	x	x
Agricultural Best Management Practices	farmland	Plant cover/manure crops	x	x	x		
	farmland	Implement conservation tillage practices		x	x		x
	farmland	Implement grass/legume rotations		x	x		x
	farmland	Convert to permanent hayland		x	x		
	farmland	Install grassed waterways		x	x		
	farmland	Install vegetated buffer areas/strips	x	x	x		x
	farmland	Install location-specific conservation buffer	x				
	farmland	Install / restore wetlands					x
	nutrients / agro-chemicals	Conduct soil testing					x
	nutrients / agro-chemicals	Install nitrogen reduction practices					x
	nutrients / agro-chemicals	Develop nutrient management plans					x
	drainage	Install sinkhole stabilization structures					
	drainage	Install controlled drainage system					
	drainage	Implement drainage water management					
	drainage	Construct overwide ditch					
	drainage	Construct 2-stage channel					
	livestock	Implement prescribed & conservation grazing practices	x				
	livestock	Install livestock exclusion fencing	x				
	livestock	Install livestock crossings	x				
	livestock	Install alternative water supplies	x				
	livestock	Install livestock access lanes	x				
	manure	Implement manure management practices	x				
	manure	Construct animal waste storage structures	x				
	manure	Implement manure transfer practices	x				
	manure	Install grass manure spreading strips	x				
	misc. infrastructure and mgt	Install chemical mixing pads					
	misc. infrastructure and mgt	Install heavy use feeding pads					
	misc. infrastructure and mgt	Install erosion & sediment control structures		x	x		
	misc. infrastructure and mgt	Install roof water management practices					
	misc. infrastructure and mgt	Install milkhouse waste treatment practices					

Restoration Categories		Specific Restoration Actions	Upper Ottawa River (04100007 03)				
			Middle Hog Creek (03 02)	Little Hog Creek (03 03)	Lower Hog Creek (03 04)	Lost Creek (03 05)	Lima Reservoir-Ottawa River (03 06)
		Develop whole farm management plans					
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions				x	x
		Develop local comprehensive land use plans				x	x
	construction practices	Implement erosion controls					
		Implement sediment controls					
		Implement non-sediment controls				x	x
	post construction practices	Reduce pollutant(s) through treatment				x	x
		Reduce pollutant(s) through flow/volume management				x	x
	post development/ storm water retrofit	Implement erosion controls					
		Implement sediment controls					
		Implement non-sediment controls				x	x
		Reduce pollutant(s) through treatment				x	x
		Reduce pollutant(s) through flow/volume management				x	x
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan (CSOs)					x
		Develop/implement local ordinances/resolutions				x	
		Develop water quality management/208 plans					
	collection and new treatment	Install sewer systems in communities					
		Implement long-term control plan (CSOs)					x
		Eliminate SSOs/CSOs/by-passes	x			x	x
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)	x				x
		Improve quality of effluent	x	x			x
	monitoring	Establish ambient monitoring program					
		Increase effluent monitoring					x
	alternatives	Establish water quality trading					
	construction practices	Issue permit(s) and/or modify permit limit(s)					
		Implement erosion controls					
		Implement sediment controls					
		Implement non-sediment controls					
	post construction practices	Issue permit(s) and/or modify permit limit(s)					
		Reduce pollutant(s) through treatment					
		Reduce pollutant(s) through flow/volume management				x	
	post development/ storm water	Issue permit(s) and/or modify permit limit(s)					
		Implement erosion controls					
		Implement sediment controls					

Restoration Categories		Specific Restoration Actions	Upper Ottawa River (04100007 03) Middle Hog Creek (03 02)	Little Hog Creek (03 03)	Lower Hog Creek (03 04)	Lost Creek (03 05)	Lima Reservoir-Ottawa River (03 06)
	retrofit	Implement non-sediment controls					
		Reduce pollutant(s) through treatment					
		Reduce pollutant(s) through flow/volume management					
		Reduce volume to CSOs					

To address the urban runoff issues in the Lost Creek nested subwatershed, permitted facilities should evaluate their facilities for sources of nutrients and consider implementing BMPs to address the sources. Based on their Storm Water Management Program, MS4s should be investigating ways to implement post-construction BMPs and retrofits that are more efficient at nutrient removal.

The primary documented fish kill in 2008 came from an illicit discharge in an unnamed tributary to Lost Creek. Regulated MS4s should implement illicit discharge detection and elimination (IDDE) programs. This would include ensuring the permittees have their ordinances in place with no loopholes and prioritizing and increasing the outfall dry weather screening in applicable areas. Industries should follow through on non-storm discharge evaluation requirements, making sure they have up-to-date requirements and that they are doing their quarterly visual assessments.

Ada is planning to begin work to expand its facility beginning in the summer of 2012. The permit has a compliance schedule and construction will last for two years. The expansion will improve treatment and eliminate a headwork bypass. It will also improve the chronic ammonia issues at the plant.

Two dams in this subwatershed should be investigated for potential to remove or modify them. The dams are located at Roush Road and at Fetter Road. Ohio EPA did not sample biology at the Fetter Road site, so further investigation will be necessary to determine the impact the lowhead dam is having on the stream. Addressing other sources of impairment may be more effective at improving water quality in the short term.

It is possible that land in the Johnny Appleseed Metroparks areas might have wetlands installed or restored in riparian areas to improve water quality.

The City of Lima is working toward a consent decree with U.S. EPA that will require the city to implement the recommendations in a long term control plan (LTCP). The LTCP chapters are being submitted and reviewed, and early action projects were included in the draft renewal NPDES permit. The river is in biological non-attainment for approximately 10 miles downstream of the Lima WWTP, a reduction of nearly 30 miles of impairment. CSO screens likely improved the biological performance, along with improvements in treatment at the Lima Refining Company and improved treatment at PCS Nitrogen. There is a compliance schedule for wet weather projects in the draft Lima renewal NPDES permit.

6.4 Middle Ottawa River (04100007 04)

Tributaries in urban areas (Little Ottawa River and Zurmehly Creek) had larger issues with organic enrichment from sewer inputs including SSOs and/or CSOs. Grey water, deposits of black anoxic solids, sewage fungus and active SSOs were all observed on the Little Ottawa River. Honey Run is on county maintenance and is affected by practices associated with cultivated cropland, so its recommendations focus on agricultural BMPs. Sites on the Ottawa River mainstem downstream from Lima are impaired from dams and from point sources; see Section 6.2 for more specific recommendations related to these sources.

Table 6-7. Recommended implementation actions in the Middle Ottawa River subwatershed.

Restoration Categories		Specific Restoration Actions	Middle Ottawa River (04100007 04)					
			Little Ottawa River (04 01)	Dug Run-Ottawa River (04 02)	Honey Run (04 03)	Pike Run (04 04)	Leatherwood Ditch (04 05)	Beaver Run-Ottawa River (04 06)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering	x		x			
		Restore streambank by recontouring or regrading	x		x			
	planted	Plant grasses in riparian areas						
		Plant prairie grasses in riparian areas						
		Remove/treat invasive species						
		Plant trees or shrubs in riparian areas	x		x			
Stream Restoration		Restore flood plain						
		Restore stream channel						
		Install in-stream habitat structures						
		Install grade structures						
		Construct 2-stage channel						
		Restore natural flow						
Wetland Restoration		Reconnect wetland to stream						
		Reconstruct & restore wetlands						
		Plant wetland species						
Conservation Easements		Acquire conservation easements	x		x			
Dam Modification or		Remove dams		R				

Restoration Categories		Specific Restoration Actions	Middle Ottawa River (04100007 04): Little Ottawa River (04 01)	Dug Run-Ottawa River (04 02)	Honey Run (04 03)	Pike Run (04 04)	Leatherwood Ditch (04 05)	Beaver Run-Ottawa River (04 06)
Removal		Modify dams						
		Remove associated dam support structures						
		Install fish passage and/or habitat structures						
		Restore natural flow		x				
Levee or Dike Modification or Removal		Remove levees						
		Breach or modify levees						
		Remove dikes						
		Modify dikes						
		Restore natural flood plain function						
Abandoned Mine Land Reclamation	treatment	Construct lime dosers						
		Install slag leach beds						
		Install limestone leach beds						
		Install limestone channels						
		Install successive alkalinity producing systems						
		Install settling ponds						
		Install vertical flow ponds						
		Install limestone drains (anoxic and/or oxic)						
		Construct acid mine drainage wetland						
	flow diversion	Repair subsidence sites						
		Reclaim pit impoundments						
		Reclaim abandoned mine land						
		Eliminate stream captures						
		Eliminate mine drainage discharges						
		Restore positive drainage						
		Cover toxic mine spoils						
Home Sewage Planning and Improvement		Develop HSTS plan	x	x			x	x
		Inspect HSTS	x	x			x	x
		Repair or replace traditional HSTS	x	x			x	x
		Repair or replace alternative HSTS	x	x			x	x
Education and Outreach		Host meetings, workshops, and/or other events	x	x	x		x	x
		Distribute educational materials	x	x	x		x	x

Restoration Categories		Specific Restoration Actions	Middle Ottawa River (04100007 04)					
			Little Ottawa River (04 01)	Dug Run-Ottawa River (04 02)	Honey Run (04 03)	Pike Run (04 04)	Leatherwood Ditch (04 05)	Beaver Run-Ottawa River (04 06)
Agricultural Best Management Practices	farmland	Plant cover/manure crops			x		x	
		Implement conservation tillage practices			x			
		Implement grass/legume rotations			x			
		Convert to permanent hayland						
		Install grassed waterways						
		Install vegetated buffer areas/strips			x			
		Install location-specific conservation buffer						
		Install / restore wetlands						
	nutrients / agro-chemicals	Conduct soil testing			x			
		Install nitrogen reduction practices			x			
		Develop nutrient management plans			x		x	
	drainage	Install sinkhole stabilization structures						
		Install controlled drainage system						
		Implement drainage water management						
		Construct overwide ditch						
		Construct 2-stage channel						
	livestock	Implement prescribed & conservation grazing practices					x	
		Install livestock exclusion fencing					x	
		Install livestock crossings					x	
		Install alternative water supplies					x	
		Install livestock access lanes					x	
	manure	Implement manure management practices					x	
		Construct animal waste storage structures					x	
		Implement manure transfer practices					x	
		Install grass manure spreading strips					x	
	misc. infrastructure and mgt	Install chemical mixing pads						
		Install heavy use feeding pads						
		Install erosion & sediment control structures						
		Install roof water management practices						
		Install milkhouse waste treatment practices						
		Develop whole farm management plans					x	

Restoration Categories		Specific Restoration Actions	Middle Ottawa River (04100007 04)					
			Little Ottawa River (04 01)	Dug Run-Ottawa River (04 02)	Honey Run (04 03)	Pike Run (04 04)	Leatherwood Ditch (04 05)	Beaver Run-Ottawa River (04 06)
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions	x	x				
		Develop local comprehensive land use plans	x	x				
	construction practices	Implement erosion controls						
		Implement sediment controls						
		Implement non-sediment controls	x	x				
	post construction practices	Reduce pollutant(s) through treatment	x	x				
		Reduce pollutant(s) through flow/volume management	x	x				
	post development/ storm water retrofit	Implement erosion controls						
		Implement sediment controls						
		Implement non-sediment controls	x	x				
		Reduce pollutant(s) through treatment	x	x				
		Reduce pollutant(s) through flow/volume management	x	x				
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan (CSOs)						
		Develop/implement local ordinances/resolutions						
		Develop water quality management/208 plans						
	collection and new treatment	Install sewer systems in communities	x			x		
		Implement long-term control plan (CSOs)						
		Eliminate SSOs/CSOs/by-passes	x	x				
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)	x	x				
		Improve quality of effluent	x	x				
	monitoring	Establish ambient monitoring program						
		Increase effluent monitoring	x	x				
	alternatives	Establish water quality trading						
	construction practices	Issue permit(s) and/or modify permit limit(s)						
		Implement erosion controls						
		Implement sediment controls						
		Implement non-sediment controls						
	post construction practices	Issue permit(s) and/or modify permit limit(s)						
		Reduce pollutant(s) through treatment						
		Reduce pollutant(s) through flow/volume management						
	post	Issue permit(s) and/or modify permit limit(s)						

Restoration Categories		Specific Restoration Actions	Middle Ottawa River (04100007 04)					
			Little Ottawa River (04 01)	Dug Run-Ottawa River (04 02)	Honey Run (04 03)	Pike Run (04 04)	Leatherwood Ditch (04 05)	Beaver Run-Ottawa River (04 06)
	development/ storm water retrofit	Implement erosion controls						
		Implement sediment controls						
		Implement non-sediment controls						
		Reduce pollutant(s) through treatment						
		Reduce pollutant(s) through flow/volume management						
		Reduce volume to CSOs						

The Allentown dam is impairing biological life in the Ottawa River. The city of Lima is investigating the possible removal of the dam.

The Indian Village Mobile Home Park connected to the Shawnee WWTP, so water quality improvement should occur prior to the next survey by Ohio EPA.

It would benefit water quality if Gomer and Rimer, two small unsewered communities, were to connect to a larger sewer system or provide centralized wastewater collection and treatment facilities. In the interim, inspecting and fixing failing HSTS would improve water quality.

Agricultural best management practices (BMPs) and conservation easements are recommended for Honey Run. However, as this stream is on active maintenance by the county engineer, these recommendations have a lower priority.

6.5 Lower Ottawa River (04100007 05)

Although improvement has been noted in Plum Creek since Ohio EPA's survey in 1996, it continues to be impaired by CSOs and the WWTP in Columbus Grove and by modified habitat, reducing the stream's assimilative capacity. Columbus Grove has an approved long-term control plan that will completely eliminate CSOs. In addition, the WWTP is in the process of upgrades to improve treatment. Downstream from Columbus Grove, agricultural practices associated with cultivated crop land are contributing to aquatic life use impairment. The only impairment in the Sugar Creek nested subwatershed is of the recreation use, which is impaired by an unsewered community (Vaughnsville).

Table 6-8. Recommended implementation actions in the Lower Ottawa River subwatershed.

Restoration Categories		Specific Restoration Actions	Lower Ottawa River (04100007 05)	
			Sugar Creek (05 01)	Plum Creek (05 02)
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering		x
		Restore streambank by recontouring or regrading		x
	planted	Plant grasses in riparian areas		x
		Plant prairie grasses in riparian areas		x
		Remove/treat invasive species		
		Plant trees or shrubs in riparian areas		x
Stream Restoration		Restore flood plain		
		Restore stream channel		
		Install in-stream habitat structures		
		Install grade structures		
		Construct 2-stage channel		
		Restore natural flow		
Wetland Restoration		Reconnect wetland to stream		
		Reconstruct & restore wetlands		
		Plant wetland species		
Conservation Easements		Acquire conservation easements		x
Dam Modification or Removal		Remove dams		
		Modify dams		
		Remove associated dam support structures		
		Install fish passage and/or habitat structures		
		Restore natural flow		
Levee or Dike Modification or Removal		Remove levees		
		Breach or modify levees		
		Remove dikes		
		Modify dikes		
		Restore natural flood plain function		
Abandoned Mine Land Reclamation	treatment	Construct lime dosers		
		Install slag leach beds		
		Install limestone leach beds		
		Install limestone channels		
		Install successive alkalinity producing systems		
		Install settling ponds		
		Install vertical flow ponds		
		Install limestone drains (anoxic and/or oxic)		
		Construct acid mine drainage wetland		
	flow diversion	Repair subsidence sites		
		Reclaim pit impoundments		

Restoration Categories		Specific Restoration Actions	Lower Ottawa River (04100007 05)	
			Sugar Creek (05 01)	Plum Creek (05 02)
		Reclaim abandoned mine land		
		Eliminate stream captures		
		Eliminate mine drainage discharges		
		Restore positive drainage		
		Cover toxic mine spoils		
Home Sewage Planning and Improvement		Develop HSTS plan	x	
		Inspect HSTS	x	
		Repair or replace traditional HSTS	x	
		Repair or replace alternative HSTS	x	
Education and Outreach		Host meetings, workshops, and/or other events	x	x
		Distribute educational materials	x	x
Agricultural Best Management Practices	farmland	Plant cover/manure crops		x
		Implement conservation tillage practices		x
		Implement grass/legume rotations		x
		Convert to permanent hayland		x
		Install grassed waterways		x
		Install vegetated buffer areas/strips		x
		Install location-specific conservation buffer		
		Install / restore wetlands		
	nutrients / agro-chemicals	Conduct soil testing		x
		Install nitrogen reduction practices		x
		Develop nutrient management plans		x
	drainage	Install sinkhole stabilization structures		
		Install controlled drainage system		
		Implement drainage water management		
		Construct overwide ditch		
		Construct 2-stage channel		
	livestock	Implement prescribed & conservation grazing practices		
		Install livestock exclusion fencing		
		Install livestock crossings		
		Install alternative water supplies		
		Install livestock access lanes		
	manure	Implement manure management practices		
		Construct animal waste storage structures		
		Implement manure transfer practices		
		Install grass manure spreading strips		
	misc. infrastructure	Install chemical mixing pads		
		Install heavy use feeding pads		

Restoration Categories		Specific Restoration Actions	Lower Ottawa River (04100007 05)	
			Sugar Creek (05 01)	Plum Creek (05 02)
	and mgt	Install erosion & sediment control structures		x
		Install roof water management practices		
		Install milkhouse waste treatment practices		
		Develop whole farm management plans		x
Storm Water Best Management Practices	planning	Develop/implement local ordinances/resolutions		
		Develop local comprehensive land use plans		
	construction practices	Implement erosion controls		
		Implement sediment controls		
		Implement non-sediment controls		
	post construction practices	Reduce pollutant(s) through treatment		
		Reduce pollutant(s) through flow/volume management		
	post development/ storm water retrofit	Implement erosion controls		
		Implement sediment controls		
		Implement non-sediment controls		
		Reduce pollutant(s) through treatment		
		Reduce pollutant(s) through flow/volume management		
Regulatory Point Source Controls (includes Storm Water, Sanitary, and Industrial)	planning	Develop long-term control plan (CSOs)		
		Develop/implement local ordinances/resolutions		
		Develop water quality management/208 plans		
	collection and new treatment	Install sewer systems in communities	x	
		Implement long-term control plan (CSOs)		x
		Eliminate SSOs/CSOs/by-passes		x
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)		x
		Improve quality of effluent		x
	monitoring	Establish ambient monitoring program		x
		Increase effluent monitoring		x
	alternatives	Establish water quality trading		
	construction practices	Issue permit(s) and/or modify permit limit(s)		
		Implement erosion controls		
		Implement sediment controls		
		Implement non-sediment controls		
	post construction practices	Issue permit(s) and/or modify permit limit(s)		
		Reduce pollutant(s) through treatment		
		Reduce pollutant(s) through flow/volume management		
	post development/ storm water retrofit	Issue permit(s) and/or modify permit limit(s)		
		Implement erosion controls		
		Implement sediment controls		
		Implement non-sediment controls		
		Reduce pollutant(s) through treatment		

Restoration Categories		Specific Restoration Actions	Lower Ottawa River (04100007 05)	
			Sugar Creek (05 01)	Plum Creek (05 02)
		Reduce pollutant(s) through flow/volume management		
		Reduce volume to CSOs		

Vaughnsville is a small unsewered community that is distant from existing sewer systems. Water quality would improve if Vaughnsville were to connect to a larger sewer system or provide centralized wastewater collection and treatment facilities. In the interim, inspecting and fixing failing HSTS would help water quality.

Columbus Grove has a LTCP in place and is implementing it. The LTCP will result in complete sewer separation. In addition, the WWTP needs substantial upgrades; they have begun the work to improve the WWTP.

Agricultural BMPs downstream from Columbus Grove, such as improved riparian habitat and nutrient management, would help to improve water quality. Improving habitat can often increase assimilative capacity of streams, which helps to abate impacts from pollutants such as nutrients. In addition, habitat improvements often directly reduce sediment from runoff-based and streambank erosion.

6.6 Reasonable Assurances

The recommendations made in this TMDL report will be carried out if the appropriate entities work to implement them. In particular, activities that do not fall under regulatory authority require that there be a committed effort by state and local agencies, governments, and private groups to carry out and/or facilitate such actions. The availability of adequate resources is also imperative for successful implementation.

When a TMDL is developed for waters impaired by point sources only, the issuance of a NPDES permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with the assumptions and requirements of any available wasteload allocation in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, U.S. EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. To this end, Appendix E discusses organizations and programs that have an important role or can provide assistance for meeting the goals and recommendations of this TMDL. Efforts specific to this watershed are described in this section.

6.6.1 Local Zoning and Regional Planning

The watershed extends across 22 townships in five counties. Seventeen are zoned and those five not zoned are:

- Monroe Township in Allen County
- Liberty, Washington and Marion townships in Hardin County
- Sugar Creek Township in Putnam County

None of the zoning regulations provide for riparian setbacks.

6.6.2 Local Watershed Groups

The Ottawa River Coalition (ORC) is a nonprofit organization established in 1993 in response to increasing attention to water quality issues. It represents the collaborative efforts of some 45 member and partner organizations. The Coalition is committed to promoting public awareness and educating the public of the benefits of improving water quality, working collectively to understand and protect water quality, continuing to study and monitor the river system, seeking an adequate financial base to maintain operations of the organization, and providing a forum for stakeholders representing the varying viewpoints and uses of the watershed. The mission of the organization is to promote the wise use and management of the Ottawa River and its watershed as a valuable community resource. More information can be found by visiting www.thisismyriver.org.

6.6.3 Other Sources of Funding and Special Projects

The watershed currently has a grant from RBC Markets LLC based in Cincinnati, Ohio. The $20,000 grant was awarded to support public outreach in the Ottawa River watershed. With those funds, the Ottawa River Coalition is producing a video project to celebrate the water quality improvements and challenge the community to take an active role in achieving more.

The Coalition was the past recipient of 319 grants in 1995 and 2000. Other major grant projects have been funded by Clean Ohio Greenspace, Lake Erie Protection Fund, and ODNR.

6.6.4 Past and Ongoing Water Resource Evaluation

Ohio EPA personnel have previously conducted biological and/or chemical monitoring in the Ottawa River during 1974 through 1979, 1985 through 1987, 1989, 1991 and 1996. Even before the Clean Water Act was passed and the Ohio EPA was created, the Ottawa River was the subject of numerous studies by the Ohio Department of Health in 1953 and 1966, other researchers in 1957, 1960, 1965, 1966, 1969, 1979, 1981 and 1984.

The river has evolved from a heavily polluted waterway devoid of fish for up to 37 miles downstream of Lima in the 1960s, to a continuously improving watershed that has achieved all biological goals at 68 percent of the sampled sites in 2010. Only 9 percent of sampled sites met no biological goals.

In 1993, when the Ottawa River Coalition came together, the Ottawa River watershed was already one of the most heavily studied watersheds in the state. The watershed population peaked with the 1880s oil boom, as Lima was considered the oil producing capital in the world. This small stream with seasonal intermittent tendencies supports a very large population and urbanized area.

The Coalition, through two 319 grants, collected approximately 8 years of stream monitoring data from 1995 through 2003. Approximately 20 stream sites, nearly half of them in the main channel and the remainder near the mouth of 10 tributary systems, were involved in the monitoring. Volunteers conducted weekly stream sampling from March through October annually. A quality assurance project plan (QAPP) clarified the monitoring procedures and was approved by Ohio EPA in 2000. The original goal of the monitoring program was to extend previous efforts by Ohio EPA throughout the entire watershed. The ORC believes that their monitoring efforts produced reliable and predictable trend data for almost all the sites. This monitoring was suspended in 2003 in anticipation of a TMDL study that was originally scheduled for 2005.

In 1993, the Coalition assembled an archive file of all the known studies of the Ottawa River and its tributaries. It has since been converted to electronic format. The ORC has no current plans for additional studies of the Ottawa River system, other than assessments required for engineering and permitting of lowhead dam enhancements or removal.

Recommended Approach for Gathering and Using Available Data

Early communications should take place between the Ohio EPA and any potential collaborators to discuss research interests and objectives. Areas of overlap should be identified and ways to make all parties research efforts more efficient should be discussed. Ultimately, important questions can be addressed by working collectively and through pooling resources, knowledge and data.

6.6.5 Potential and Future Evaluation

The ORC is currently searching for approximately $60,000 to design and permit enhancements to two lowhead dams (city of Lima) as a demonstration and the complete removal of another dam at Allentown.

The Coalition’s activities are being conducted in conjunction with Phase II Stormwater Program collaboration. They plan to attain a credible data monitoring certification.

6.6.6 Revision to the Improvement Strategy

The Ottawa River (Lima area) watershed would benefit from an adaptive management approach to restoring water quality. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current strategy is inadequate or ineffective. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack *et al.* 1999).

If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the improvement strategy has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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