

Chapter 1

Areawide Overview

Introduction

Purpose of the Areawide Water Quality Management Plan

The *Areawide Water Quality Management Plan's* purpose is to assist efforts to achieve the “fishable and swimmable” water quality standards of the Clean Water Act. As the word “Areawide” signifies, this Plan takes a comprehensive regional approach to water quality protection.

The Areawide region covers Lucas, Ottawa, Sandusky, and Wood Counties in Ohio, and Bedford, Erie, and Whiteford Townships of Monroe County, Michigan — all at the southwest end of Lake Erie. In this region, there are 115 local governments, not counting Special Districts and Authorities. Many of these jurisdictions have a role in protecting water quality. In addition, there are many local, state, federal, regional, and bi-national governmental agencies with environmental protection duties. The purpose of this Plan is to provide these stakeholders with a means to address water quality issues on a regional level.

The *Areawide Water Quality Management Plan* contains seven chapters. They incorporate the region’s environmental goals and policies, describe the responsibilities of specific local governments to implement the Clean Water Act and provide sanitary sewerage service, and identify best management practices to control water pollution from diffuse sources, especially due to stormwater runoff (“non-point sources”). The chapters are as follows:

1. Areawide Overview
2. Environmental Policies
3. Water Quality Management Framework
4. Public Wastewater Treatment
5. On-Site Sewage Treatment
6. Agricultural Runoff
7. Stormwater Management

This first chapter serves three purposes. First, it describes the lay of the land: the region’s geology, geography, and natural resources. The intent is to provide enough background to understand the chapters that follow, and references for further information. Second, it summarizes the state of water quality in our region. Third, this chapter explains the legal basis for the “208” *Areawide Water Quality Management Plan*, and its amendment process.

Physical Setting and Water Quality

Water Quality Management

We are often inclined to assume, when we speak of water quality management, that both problems and solutions are directly related to what we do to “manage” water quality. Whether it is a question of supplying water for our uses, or of treating wastes, our thoughts first turn to technology and manipulation, as if the whole problem of water quality in the Toledo Metropolitan Area Council of Governments (TMACOG) region could be solved by a grand plumbing scheme and enough money to pay for it. This is not so. The problem is essentially a problem of land use; it is a problem that arises from the demands which human activities make upon a part of the land that cannot meet them. One of the consequences of the problem is its effect on water quality, but it does not follow that by treating the wastewater in a plant, the problem will be solved most economically or effectively.

We can reduce impacts from sewage by treating it and discharging clean effluent. Reducing impacts from diffuse non-point sources is a matter of prevention through “Best Management Practices” (BMPs). The term “refers to a practice that is determined by a state after examination of alternative practices to be practicable and most effective in preventing or reducing the amount of pollution generated by a non-point source to a level compatible with water quality goals.”¹ The general criteria for selecting BMPs are:

- A BMP should be effective in reducing water pollution from non-point sources.
- A BMP should be effective in helping waterways meet Clean Water Act “fishable and swimmable” goals.
- A BMP should be practicable.²

Protection of water quality requires that we know the region and understand the natural environment’s processes. If we understand the limitations and capabilities of the place, and adapt policies to them, we will continue to have an excellent water supply and recreation on Lake Erie that will draw visitors nationwide.

In Ohio, non-point programs are managed by Ohio Environmental Protection Agency (EPA) and Ohio Division of Natural Resources (DNR). The *Nonpoint Source Assessment*³ provided background and data on nonpoint source water pollution in Ohio. It was followed by the *Nonpoint Source Management Program*,⁴ which identified sources of nonpoint pollution and policies to guide state programs. Ohio DNR developed its *Ohio’s Coastal Management Program* specific to the protection and restoration of Lake Erie and its coastal zone.⁵

Both Ohio and Michigan administer cost-share programs to encourage BMPs with United States Environmental Protection Agency (US EPA) “§319” Nonpoint Source funds. These programs provide financial incentives for property owners to use BMPs that will reduce pollution from agricultural runoff and septic systems in particular. Use of these funds is guided locally through watershed plans. In the TMACOG region, the principle watershed councils are the Maumee Remedial Action Plan (RAP), Portage River Basin Council (PRBC), Duck & Otter Creek Partnership, and Sandusky River Watershed Coalition.

Geography

The region includes four geological areas.

Starting from the west are Sand Hills, former beach areas of glacial lakes, which include the Oak Openings and prairies. Some areas are well drained, though the sandy soils, when drained, are the region’s best farmland.

The center of the region is Lake Plain, former lake bottom, and includes the Great Black Swamp. This area is very flat, with heavy and slow-draining silt and clay soils. Originally there were many wet prairies, shallow lakes, and forests. After settlers cleared the forests and built artificial drainage, the area has become some of the state’s most productive farmland.

In the eastern part of the region are Uplands, characterized by limestone, shales, and sandstone either in outcrops or near the surface. This area generally has good drainage, but it also has sinkholes that can lead surface runoff into the aquifer.

The fourth geologic area is Lake Erie itself. All drainage from the region leads to Lake Erie. The Lake provides water supplies for residents and commerce; and recreation and habitat for fish and wildlife.

1 Quoted from US EPA National Water Quality Strategy stated in “Conservation Districts and Nonpoint Source Pollution Control,” NACD October 1975

2 Adapted from *Draft Guidelines for State and Areawide Water Quality Management Program Development*, US EPA February 1976

3 *State of Ohio Nonpoint Source Assessment* Ohio EPA 1990

4 *Ohio Nonpoint Source Management Program* Ohio DNR and Ohio EPA 1993; and the 1999 *Ohio Nonpoint Source Management Program Upgrade*

5 *Ohio Coastal Nonpoint Pollution Control Program Plan* Ohio DNR April 2007

http://www.ohiodnr.com/LakeErie/OCMP_Document/tabid/9260/Default.aspx Appendix J

The region's geographic areas, major water features, and underlying geology are illustrated in the following figure.

Aerial View of the TMACOG Region Showing Natural Features

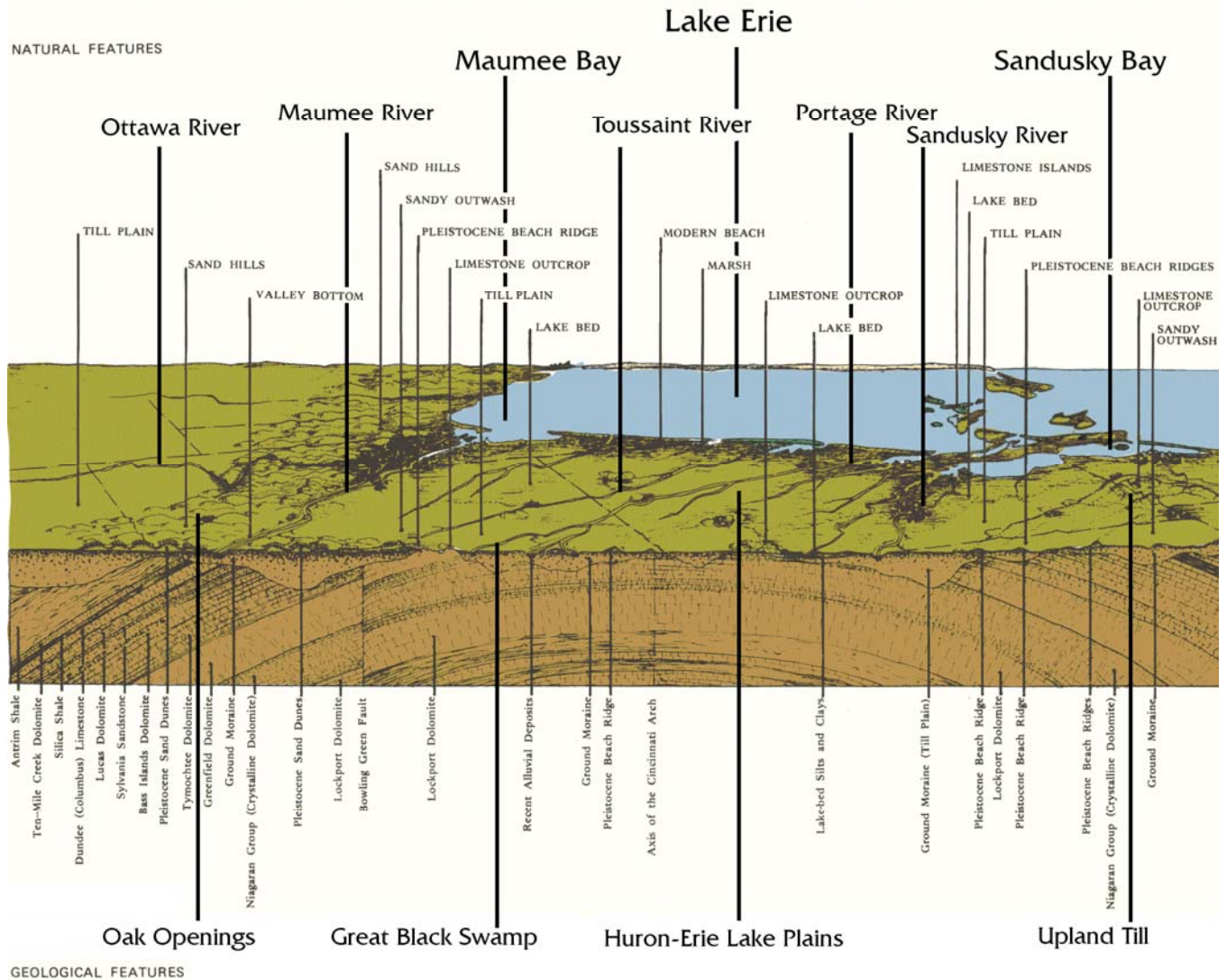


Figure 1 The TMACOG Region's Natural Features

Ecological Areas

The Great Lakes area is divided into ecoregions, which denote areas of generally similar ecosystems. They are designed to serve as a framework for the research, assessment, management, and monitoring of ecosystems.⁶

Nearly the entire TMACOG region is within the Huron/Erie Lake Plains Ecoregion. The ecoregion takes its name from its being formed by retreating glacial lakes. US EPA describes it as "Fine, poorly-drained, water-worked glacial till and lacustrine sediment; also coarser end moraine and beach ridge deposits."

⁶ *Ecoregions of Indiana and Ohio* US EPA Western Ecology Division, Corvallis, OR

http://www.epa.gov/wed/pages/ecoregions/ohin_eco.htm

estimated that there are three miles of man-made ditches to every mile of natural stream. Today, there are “square mile” ditches along many roads in Wood, Ottawa, and Sandusky Counties. Drainage ditches make productive farming possible, but many do not provide fish or wildlife habitat. Ditches that lack buffer areas and are farmed up to the ditch bank provide a route for nutrients and sediment runoff to Lake Erie.

Despite draining and channelizing streams, the swamp is still there. It remains subject to flooding, particularly along the Portage Middle Branch in eastern Wood County. Black Swamp streams could be good candidates for restoration and re-establishment of habitat by expanding floodplains and wetlands. Habitat areas on these headwater streams support the base of the food chain, which ultimately feeds Lake Erie.



The name “Black Swamp” refers to a large flat area in northwestern Ohio that was once in truth a broad, deep swamp. Oriented northeast southwest along the south side of the Maumee River, it is about 100 miles long and 20-30 miles wide. The swamp was located on the broad plain that was once the bottom of an early, ancestral Lake Erie, whose surface was over a hundred feet higher than the modern lake because of a dam of glacial ice in the northeastern part of the Erie basin. This ice, the remains of the great glaciers that once covered much of Ohio, formed a dam holding back this early lake for a short time, and then melted away completely from the area. Here, where the bottom of that early lake had been lowest and flattest, and where the finest of the lake clays had been deposited, adequate natural drainage was impossible, resulting in the formation of the swamp. Black muck associated with this swamp gave the area its name.

Before the swamp was drained, it was the main impediment to travel between Ohio and Michigan. The difficulties presented by the swamp to the early settlers and soldiers are clearly indicated in

their writings, of which the following are excerpts (taken from pages 3-7 of a paper by Martin R. Kaatz in the 1955 *Annals of the Association of American Geographers*). David Zeisberger, a Moravian missionary, describes the “deep swamps and troublesome marshes”, where no bit of dry land was to be seen, and the horses at every step wading up to their knees”, it took him two and a half days to travel from Sandusky to the Maumee River, a distance of about 30 miles. Joseph Badger refers to the “hideous swamps” and Brown wrote about the problems faced by General Hull’s army in the War of 1812: “man and horse had to travel mid leg deep in mud” and “the mud was ankle deep in our tents”.

Early farmers ditched their land, but without major drainage ways to carry away the ditch water, this was not very effective. In 1859, a law providing for public ditches was passed, with the result that the entire swamp was drained and more people began to settle there. Rural population reached its peak about the turn of the century, 50 years later than in the rest of Ohio. Soils were so productive in this newly drained land that more of the land was put into crops here than anywhere else in Ohio. What was once a vast muddy swamp on the flats of an old postglacial lake-bed has become one of Ohio’s most productive rural areas.⁹

The Oak Openings

The region’s single most important natural habitat area is the Oak Openings region, bordering the Great Black Swamp. The Maumee RAP¹⁰ calls for preservation and acquisition of fish and wildlife habitats, specifically recommending wet prairies and oak savannahs of western Lucas County, in the *Oak Openings area*. *The Swan Creek Plan of Action*¹¹ gives its highest priority to preserving floodplains and wetlands as natural habitats.

The Oak Openings Region, located within portions of the Swan Creek and Ottawa River watersheds, is a 130 square mile area supporting globally rare oak savanna and wet prairie habitats. It is home to more rare species of plants and animals than any other area of Ohio. Its trees, plants, sandy soils, wet prairies, and floodplains benefit the region by acting as natural filters for our air and water.

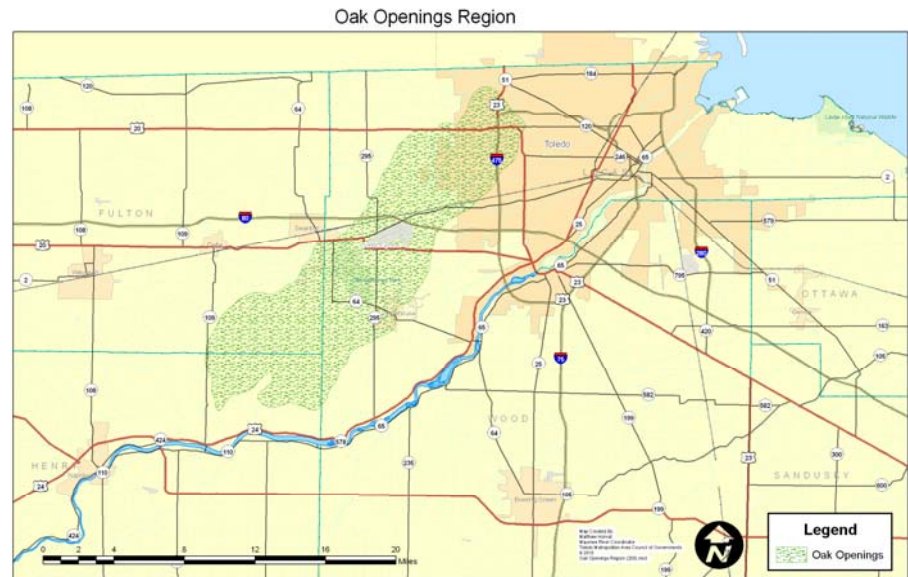


Figure 4 Oak Openings

Natural floodplain corridors occur between the Oak Openings Region and Lake Erie along the Maumee River, Swan Creek, and Ottawa River. Preserved natural floodplains in these areas help to balance the effects of development and the resulting downstream effects of increased urban runoff. Floodwater is slowed within the broad forested areas of the floodplain allowing for groundwater replacement and evaporation to take place.

9 Dr. Jane Forsyth, Bowling Green State University, Professor Emeritus, Geology

10 TMACOG, Maumee RAP Advisory Committee: *Recommendations for Implementation* July 1991 §§2.3.3, 2.3.4

11 TMACOG, Maumee RAP: *Swan Creek Plan of Action*, 2002

The Oak Openings Region with its wet prairies and savannas, together with the connecting corridors along the Maumee River, Swan Creek, and Ottawa River should be given the highest priority for preservation. By maintaining the natural character of these areas, they will continue to benefit humans and wildlife long into the future.

Coastal Wetlands

The TMACOG region includes the largest stretches of undeveloped Ohio Lake Erie coastline. The coastal natural areas provide important habitat for insects, small fish, and many birds. They include wetlands but also provide shoreline habitat and natural beauty for both recreation users and residents. With a good habitat base, the coastal areas are a strong tourism attraction for hunting, bird-watching, and hiking. Public areas set aside significant coastal areas as preserves and/or provide public access. These include Maumee Bay State Park, Cedar Point National Wildlife Refuge, Crane Creek State Park, East Harbor State Park, Ottawa Wildlife National Refuge, Metzger Marsh, Magee Marsh, Toussaint Creek Wildlife Area, and Little Portage Wildlife Area. The Davis Besse Nuclear Power Station site preserves a large area of coastal wetlands. Their habitat supports Lake Erie fisheries and wetlands that contain and remove pollutants.

Water Resources: Lake Erie

Lake Erie is the region's greatest water resource. Indeed, it is Ohio's greatest water resource. It provides fresh water for drinking, industry, shipping, transportation, recreation, and enjoyment for its own sake. Ultimately the purpose of this entire *Areawide Water Quality Management Plan* is the protection of Lake Erie.

Lake Erie is the oldest, smallest, and shallowest of the Great Lakes. It is also the warmest, most turbid, most biologically productive, and most eutrophic. Lake Erie is divided into eastern, central, and western basins. The Eastern Basin has an average depth of 80 feet and holds lake water 322 days. The Central Basin is the largest, with an average depth of 61 feet and a detention time of 635 days. The TMACOG region is on the Western Basin, which has an average depth of 24 feet and a detention time of 51 days. The Western Basin extends from the Lake's west end at Toledo to Cedar Point at Sandusky.¹²

Lake Erie is unusual among the Great Lakes for two reasons. First of all, it is extremely shallow. At its deepest, in the eastern end of its basin, the lake is 210 feet deep. In its western end, west of the series of islands north of Catawba, depths average only 24 feet and rarely exceed 30 feet. Secondly, the axis of the lake is oriented almost parallel to both the prevailing winds from the west and southwest, and to the less common but more destructive storm winds that comes from the northeast.

Wind, passing over a lake, creates waves. In addition, due to frictional drag, the wind actually pushes some of the surface water of the lake in the direction toward which it is blowing. ... The water level at the eastern end of the lake may be raised by as much as 5-6 feet, while in the western end, near Toledo, will be lowered by an equal amount. ...

This "slosh" back and forth is a characteristic feature of all lakes, and it is particularly strongly developed in lakes that happen to be large, long, and shallow, like Lake Erie. Technically, such an oscillation of water from one end of the lake to the other, produced by wind or by strong changes in atmospheric pressures, is called a seiche, or wind tide. The period, or time necessary for the water to move both ways across a lake, varies; in Lake Erie the period of the seiche is 14 hours. ... The maximum difference in level of water recorded at the west end of the lake (at Toledo) is about 12 feet, but this maximum almost never occurs; most seiches produce a difference of not more than a

12 *Lake Erie and Lake St. Clair Handbook*, Stanley J. Bolsenga and Charles E. Herdendorf, Wayne State University Press, 1993

*foot or two in the elevation of the lake*¹³

Lake Erie is sometimes likened to a long, shallow bathtub with Toledo on one end and Buffalo at the other. If you lift one end of the tub and drop it, water sloshes back and forth from one end to the other. The real Lake Erie behaves similarly, but due to wind. A wind storm can push the water northeast; levels rise at Buffalo and drop at Toledo. The weight of the high water at Buffalo then pushes back to Toledo. A seiche may include several cycles of water sloshing back and forth from one end of the lake to the other. The record water level difference between Toledo and Buffalo due to a seiche is 14 feet¹⁴, but differences of several feet are common. The seiche causes local flooding and erosion. Southwest currents can be stronger than downstream river flows. As a result, the Maumee River flows backward as far as the Maumee-Perrysburg bridge (river mile 7), and the Portage as far Oak Harbor (River Mile 12). Other streams directly tributary to Lake Erie, or whose mouths are in the seiche zone, are similarly affected.



Figure 5 Low-Water Seiche Effect on the Maumee River, September 2009

Rivers and Watersheds

The entire region drains ultimately to Lake Erie. Drainage occurs in three primary rivers, two secondary rivers, dozens of creeks, and hundreds of ditches. The US Geological Survey (USGS) defines drainage areas as “Hydrological Units.” USGS nomenclature describes drainage through a hierarchical system of “Hydrological Unit Codes” (HUCs). The more digits in the drainage area’s code, the smaller the area. Eight digit HUCs are roughly equivalent to river basins, 10 digit HUCs are equivalent to principle watersheds, and 12 digit HUCs are sub-watersheds. For instance:

13 *A Study of Physical Features for the Toledo Regional Area*, the Toledo Regional Area Plan for Action (TRAPA); Bowling Green State University Geology Department, Dr. Jane Forsyth; March 1968, pages 37-8

14 *Lake Erie and Lake St. Clair Handbook*, Stanley J. Bolsenga and Charles E. Herdendorf, Wayne State University Press, 1993 page 221

04 = Great Lakes [2 digits]
 041000 = Western Lake Erie [6 digits]
 04100010 = Cedar-Portage Ohio [8 digits]
 0410001002 = South Branch Portage River-Middle Branch Portage River [10 digits]
 041000100201 = Bull Creek [12 digits]

The river basins and watersheds are discussed in the following section.

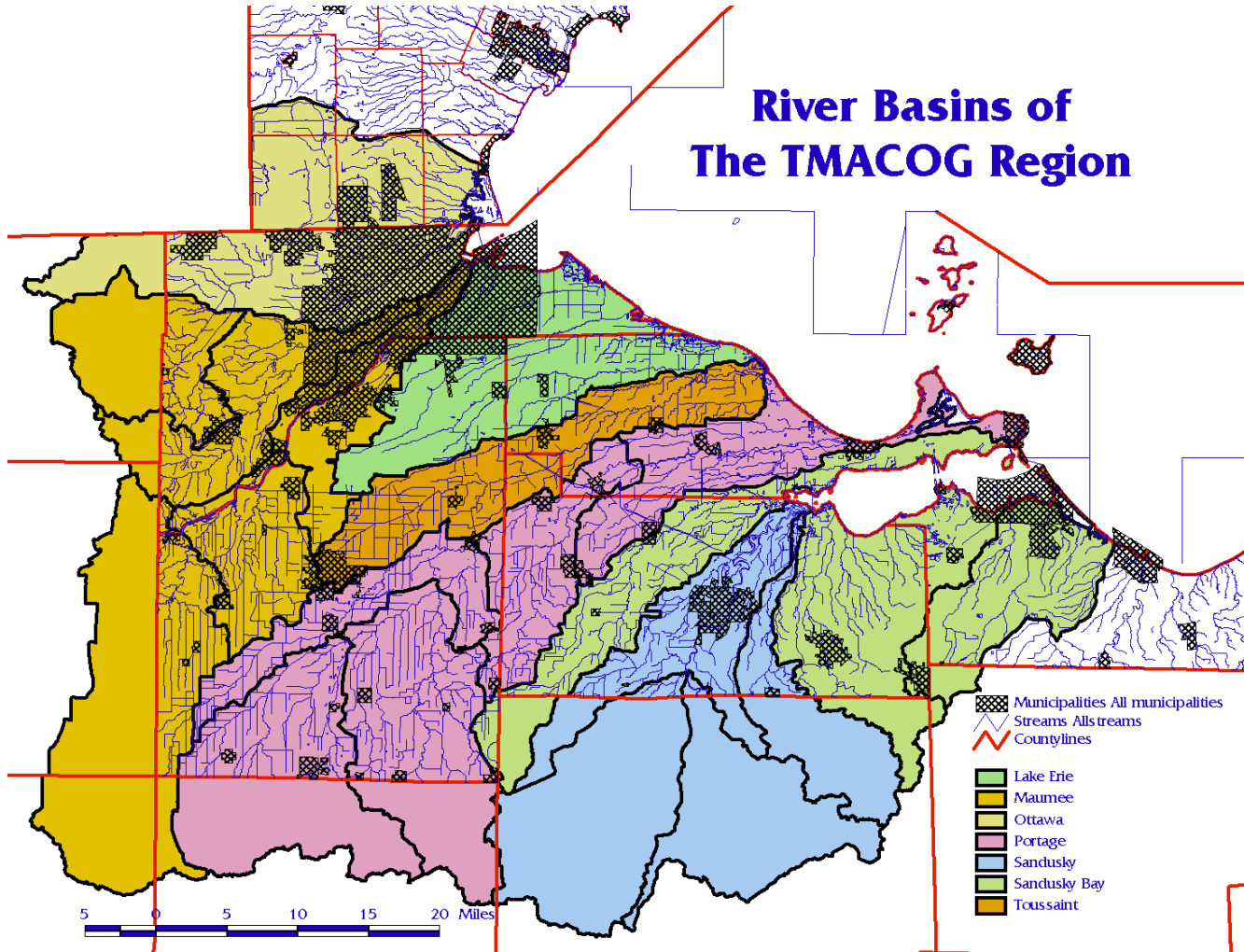


Figure 6 River Basins of the TMACOG Region

Primary Rivers

The Maumee River

The Maumee is the largest Great Lakes tributary, draining all or part of 17 Ohio counties, two Michigan Counties, and five Indiana Counties. The total river basin covers 8,316 square miles. The Maumee mainstem begins in Fort Wayne at the confluence of the St. Joseph and St. Mary’s rivers. It flows through Defiance and Napoleon, and then into Toledo. Along the way the Maumee is joined by several major tributaries: the Tiffin, Auglaize, and Blanchard. In Wood and Lucas Counties, several smaller streams flow into the Maumee: Beaver Creek and Tontogany Creek from the south; and Swan Creek, which joins the Maumee in downtown Toledo. The area in Wood and Lucas Counties draining directly into the Maumee is comparatively small. Most drainage flows through the tributaries, and then into the Maumee. Most of the Oak Openings is in the Maumee River Basin. A large part of the basin south of the river is in the Great Black Swamp. From Grand Rapids in Wood County to

Point Place near the mouth, the Maumee has a gradient of only 2 feet per mile. The steepest section is between Waterville and Maumee, at 5 feet per mile. Swan Creek's gradient is similar, at 2.1 feet per mile. Below Rossford, the Maumee is the same level as Lake Erie.¹⁵

The Portage River

The Portage is a Black Swamp river, draining a large part of Wood County, smaller parts of Hancock, Ottawa, and Sandusky Counties, and a small area in Seneca County. The total river basin covers 611 square miles. The headwater streams are the only part of the basin with substantial fall, especially in Hancock County, in the Defiance Moraine. Most of the rest of the basin is very flat and historically was covered with wet prairies and forests, and shallow lakes with little natural drainage. Settlement and farming were made possible only through draining the swamp, and preventing floods. The headwater streams of Brush Creek, Yellow Creek, and West Creek originally flowed into the Portage North Branch. They were cut off through the Jackson Cutoff Ditch in 1878-1879. Today the Jackson Cutoff Ditch flows into the Maumee River through Beaver Creek. At Oak Harbor the Portage broadens into "Portage Pond," the estuary area. This lower reach is strongly influenced by Lake Erie and seiche flows. The highest headwater tributary is the East Branch, starting at 855' in Hancock County. The lowest headwater stream is the North Branch, starting at 700' where it was cut off from Brush Creek in Wood County. At a stream length of 60 miles, the Portage's gradient ranges from 2.1 to 4.7 feet per mile down to Lake Erie at 573'.¹⁶

The Sandusky River

The Sandusky River, at 1,421 square miles, is much smaller than the Maumee, but still the second largest Ohio Lake Erie tributary. The Sandusky drains parts of ten counties, with the central part of the basin covering Sandusky, Seneca, Wyandot, and Crawford Counties. The Sandusky River basin is different geologically from the Maumee and Portage, in that only the lower portion of the river is in the Huron-Erie Lake Plains Eco-Region; the upper watershed has more relief from moraine deposits. Overall, the Sandusky has a gradient of 3.9 feet per mile from headwaters to mouth at Sandusky Bay.¹⁷ Many creeks are tributary to the Sandusky. In the TMACOG planning area, the principle tributaries are Muskellunge Creek, which drains central Sandusky County; Wolf Creek, which flows northeast from Fostoria and joins the Sandusky in Ballville Township; and Bark Creek, which flows north through eastern Fremont, and into the Sandusky near Wightman's Grove in Riley Township.

Secondary Rivers

The Ottawa River

The Ottawa River is 45 miles long with a drainage basin of 178 square miles. Its average gradient is 4 feet per mile.¹⁸ The watershed begins in northeastern Fulton County (Ohio) where the river is known as Ten Mile Creek. It flows east through Lucas County (Ohio), where it is joined by a northern branch from Lenawee and Monroe counties (Michigan). The river continues through Lucas County until it joins Maumee Bay and Lake Erie in Monroe County.

The use of the lower Ottawa River for fishing and swimming was banned in the early 1990s by the Toledo Health Department and the Ohio Department of Health. Large signs are still posted to alert the public to avoid contact with the water. The recreational industry, which once included numerous marinas, fishing

15 *A Study of Physical Features for the Toledo Regional Area*, the Toledo Regional Area Plan for Action (TRAPA); Bowling Green State University Geology Department, Dr. Jane Forsyth; March 1968, pages 23-24

16 *Portage River Watershed and Fishery* Ohio Department of Natural Resources Division of Wildlife, 1965

17 Sandusky River Watershed Resource Inventory, Sandusky River Watershed Coalition, 2002, Chapter 3

18 *A Study of Physical Features for the Toledo Regional Area*, the Toledo Regional Area Plan for Action (TRAPA); Bowling Green State University Geology Department, Dr. Jane Forsyth; March 1968, pages 23-24

charters, and water ski clubs, has been affected by the inability to use these contaminated waters. Low lake levels and sedimentation have made the river shallow and difficult to navigate.

From river mile 7 to the mouth, the Ottawa River is directly influenced by Lake Erie storm surges and seiches.¹⁹

The Toussaint River

The Toussaint is a small Black Swamp river that flows from northern Bowling Green in Wood County, through Luckey, Genoa, and Rocky Ridge, and into Lake Erie in Carroll Township of Ottawa County. The drainage basin covers 143 square miles. The Toussaint's primary tributary is Packer Creek. Above their confluence, the Toussaint is considered a creek; below it, the Toussaint widens as it reaches lake level. In this lower reach, there are two important natural areas. One is the Toussaint Creek Wildlife Area. As Toledo Edison notes, "The other is the Davis Besse property. More than 700 of the 900-plus acres Davis-Besse site is dedicated as a wildlife preserve. The site is in the migration flyway of many kinds of waterfowl, including Mallard ducks and Canada geese."²⁰

The Toussaint watershed is a highly agricultural area; the largest town is Genoa, with a population of 2,230 in 2000. The watershed includes dolomite limestone quarries near Woodville, Genoa, Clay Center, and Rocky Ridge. The former Brush Beryllium plant site in Luckey is planned for a clean-up of contaminated soil by the US Army Corps of Engineers.²¹ The Davis Besse Nuclear Power Station is located at the mouth of the Toussaint.

Bays and Lake Erie Drainage Areas

Maumee Bay

The Maumee River flows into Maumee Bay, and from there into Lake Erie. The Bay is bordered by Woodtick Peninsula in Erie Township of Monroe County Michigan, and Little Cedar Point in Jerusalem Township of Lucas County. Maumee Bay has a number of important tributaries besides the Maumee River. They include the Ottawa River, Halfway Creek, and Silver and Shantee Creeks to the north of the Maumee River; and Duck Creek, Otter Creek, Wolf Creek/Berger Ditch, as well as numerous ditches. The Maumee Bay watershed is part of the Great Black Swamp. The bay is shallow, and its shoreline has retreated greatly over the years. The shoreline of Maumee Bay retreated southward as much as 20 feet per year, the fastest shoreline recession in Ohio. Between 1844 and 1970 the southern shoreline of Maumee Bay retreated 2,000 feet.²² In 1976 the average depth of Maumee Bay was 2 feet less than 1844, and the reduction has been attributed to deposition of sediments from culturally induced processes. "The shallow depths, wind, and wave activity tend to sustain high background turbidity in the Bay."²³ Maumee Bay coastal areas include important natural habitat areas, including the Maumee Bay State Park, and Cedar Point National Wildlife Refuge.

Sandusky Bay and Mud Creek Bay

At its mouth, the Sandusky River watershed is narrow. Drainage goes directly to Sandusky Bay, through Mud Creek, and many small streams. The Sandusky Bay watershed is in the Huron-Erie Lake Plains Eco-

19 *Watershed Initiative Inter-State Nomination for the Ottawa River*, Ohio EPA and Maumee RAP November 2002

20 "Davis-Besse Nuclear Power Station," brochure Toledo Edison/Centennial Energy Corporation, page 13, no date.

21 "Beryllium Cleanup Planned," *Sentinel-Tribune*, June 14 2003

22 *A Study of Physical Features for the Toledo Regional Area*, the Toledo Regional Area Plan for Action (TRAPA); Bowling Green State University Geology Department, Dr. Jane Forsyth; March 1968, page 40

23 Maumee River Basin Area of Concern Remediation Action Plan Recommendations for Implementation TMACOG and Maumee RAP, July 1991, citing Pinsak & Meyer, 1976 page 31

Region. Eastern Sandusky, western Erie, and northeast Seneca Counties are underlain by a karst limestone geologic formation that stretches from Seneca County to Lake Erie at Sandusky. Karst bedrock is porous, with sinkholes that allow surface runoff to drain directly into groundwater. Because karst limestone is porous, water flows through it much more quickly. Drinking water sources that draw their supply from the karst aquifer are very vulnerable to contamination. The Sandusky Bay coastline includes many wetlands and natural areas, some of which are preserved in the Pickerel Creek Wildlife Area and Blue Herron Reserve.

Water Quality Baseline

Water Quality Standards

The way we measure the cleanness of water has changed with our society. We put water to many uses, and each use has its own requirements as to how clean water needs to be:

Table 1 Water Quality and Water Uses

Water Use	Water Quality Requirements
Commerce	Navigation
Industry, agriculture, power generation	Free of debris and pollutants to serve the industrial purpose, without damaging equipment or plumbing
Recreation (swimming, boating)	Microbes such as bacteria and viruses must be at low enough levels not to cause infection. Free of toxics and chemical irritants
Public supply	Must be safe to drink: free from toxics, microbes, and carcinogens, and free of unpleasant taste and odor.
Fishing	Water and sediments must be free of toxics. Nutrients (nitrates, phosphates) must be below levels that cause “toxic algae” blooms. River sediment deposits must not cover feeding or spawning areas. Water must contain dissolved oxygen to support life. Headwater streams must meet these standards to produce a food chain that ultimately feeds the fish in Lake Erie. Some fish (like carp and bluegill) are pollution tolerant, while others (like trout) are intolerant.
Natural habitat, rare or endangered species	Sediment loadings, nutrients, and toxics must be at low levels. Streams should have shaded areas to keep water cool, and riffles to provide oxygenation. The more streams that meet these qualities, including small headwater streams, the better the watershed habitat will be.

Measuring Water Quality

“Is this stream polluted?” “Is this stream cleaner than that stream?” These questions are more complicated than they sound. There are many different types of pollutants, with different impacts on human and ecological health. The earliest water pollution laws were concerned with eliminating odors and visible pollution from sewage and industrial waste. In the early days of the Clean Water Act, water was “clean” if it passed a series of chemical tests. Parameters used to measure water quality are summarized below.

Physical

Stream sampling usually includes physical characteristics of the water: temperature, acidity (pH), and sediment load (suspended solids, turbidity).

Chemical

All stream water contains chemicals. Many are benign in moderate concentrations. Some are necessary for a healthy ecosystem. Constituents include hardness (calcium, magnesium), chlorides, organic content (biochemical oxygen demand, BOD), nutrients (various forms of phosphorus and nitrogen), and dissolved oxygen. Dissolved oxygen is essential for aquatic animals; nutrients are discussed later in this chapter.

Other chemicals can be less benign, and may be toxic and/or carcinogenic.

Industrial

There are many industrial chemicals in waterways. Three categories are usually of greatest concern. Metals—cadmium (Cd), chromium (Cr), lead (Pb), copper (Cu), zinc (Zn), and mercury (Hg)—can cause toxic effects depending upon the metal and concentration. Polychlorinated biphenyls (PCBs) are recognized as probable carcinogens. Now banned, PCBs were once widely used in manufacturing. Polycyclic Aromatic Hydrocarbons (PAHs) are a related class of toxic chemicals, byproducts of petroleum products, such as creosote. Other chemicals may be present, depending on the area's industries. Other industrial chemicals include arsenic (As), cyanide (CN), phenol, and beryllium (Be).²⁴ Many industrial contaminants have a tendency to bond or diffuse into organic particles such as silts and fatty tissues in biota. As a result, these types of chemicals are often concentrated in stream sediments, where they may stay for years, move with the sediment, or enter and bioaccumulate through the food chain posing risks to higher-level animals (for example osprey, eagles and mink) as well as humans. Many industrial chemicals, like PCBs and certain PAHs are also resistant to biodegradation and remain in the environment for decades.

Pesticides

Pesticides are used to protect gardens and farms from nuisance insects and weeds. DDT has been banned for years, and is gradually decreasing in the environment. A variety of pesticides are used for agriculture and residential gardens, including “Triazines,” Atrazine and Simazine. At certain exposure levels, they are potential carcinogens. Public drinking water supplies are monitored and regulated for pesticides.²⁵ EPA notes:

Pesticides and their effects on human health are often the focus of debate between scientists, environmental groups, public water systems and the public. Two important issues included in the debate center on exposure, or the amount of these chemicals that people either ingest or inhale, and the duration of the exposure. Exposure is an important issue because the amount of a chemical either ingested or inhaled and the length of the exposure determine whether or not human health will be negatively affected. Consuming water that is contaminated with pesticides is one route of exposure that has made headlines over the last several years.

The U.S. EPA has established different drinking water criteria for both short term and long term exposure periods. For children, health advisories are established for exposure durations of 1-day, 10-days and 7-years. For adults, health advisories are calculated for 7-years and lifetimes (all health advisories are non-enforceable). In addition to health advisories, the U.S. EPA has established maximum contaminant levels (MCLs), which are enforceable standards that are based on a lifetime of exposure. Compliance with the MCL is based on a public water system's running annual average of all samples taken during a 12 month period. Consumption of water with chemical concentrations less than or equal to a health advisory or MCL for the duration of time covered by the criteria or standard is considered by U.S. EPA to pose negligible health risks.²⁶

Bacterial

Bacterial water pollution refers to bacteria from the intestinal tracts of warm-blooded animals. They cause a variety of diseases, and are discussed later in this chapter.

24 US EPA hosts an extensive website on Pollutants/Toxics with many links: <http://www.epa.gov/ebtpages/pollutants.html>.

25 US EPA's website on pesticides provides many references and links: <http://www.epa.gov/ebtpages/pesticides.html>

26 “Ohio EPA Pesticide Special Study: May 1995 Through August 1998 Summary,” Ohio EPA 1998

Biological

Today water quality is measured by a stream's ability to support life. The chemical tests are still important, but so are spawning areas, siltation, and vegetation along the stream banks. Ohio EPA classifies each stream with a "use designation." A use designation calls up a set of standards based on the water quality that could be expected in a stream. For instance, the quality of a coldwater stream flowing down out of the mountains over a rocky stream bed would likely be higher than a flat stream with a muddy bottom. The flatness of most of the streams in our region means that they are less likely to achieve high standards than streams in other parts of the state with more slope and turbulence. The majority of streams in our region are classified as Warmwater Habitat (WWH) or Modified Warmwater Habitat (MWH).²⁷

Ohio EPA measures a stream's Aquatic Life Use Designation attainment with a series of index scores. Two of the indexes are the Index of Biotic Integrity (IBI) and Invertebrate Community Index (ICI). These indexes are derived from the number of fish, insects, and invertebrates in a stream, their health, the number of different species, and how pollution-tolerant those species are. For instance, mayfly larvae are pollution intolerant, so their presence indicates good water quality.²⁸ The Ohio Water Quality Standards several other Use Designations as well, including Public Water Supply and Recreation.

Another index, the Qualitative Habitat Evaluation Index (QHEI)²⁹, measures a stream's habitat quality. It considers the stream substrate (e.g., boulders, pebbles, sand, silt, and mud); stream morphology (sinuosity, channelization, and stability); bank erosion and the riparian area along the stream (width and vegetation along the stream providing shade and habitat); and pools and riffle (providing habitat for fish and macroinvertebrates).

Total Maximum Daily Loads (TMDLs)

Under the Clean Water Act, individual states or US EPA, conduct the Total Maximum Daily Load (TMDL) program. It specifies the amount a pollutant needs to be reduced to meet water quality standards, allocates pollutant load reductions, and provides the basis for setting National Pollutant Discharge Elimination System (NPDES) permit effluent limits, and other actions needed to meet those goals³⁰. Both Ohio EPA and Michigan Department of Natural Resources and Environment (DNRE) conduct TMDLs.

The following TMDLs have been conducted in our region, as of April 2010:

- Toussaint River³¹ (approved)
- Swan Creek³² (approved)
- Lower Maumee River Tributaries³³ (in process, data available)
- Lake Erie Direct Tributaries (in process, data available)
- Portage River³⁴ (in process, data available)
- LaPointe Drain³⁵

27 Use Attainment designations and biological testing criteria are defined in Ohio Administrative Code §3745-1-07

28 More information on Ohio EPA aquatic life indexes is available at <http://epa.ohio.gov/dsw/wqs/index.aspx>

29 http://epa.ohio.gov/portals/35/documents/BioCrit88_QHEIIntro.pdf

30 <http://epa.ohio.gov/dsw/tmdl/index.aspx> and http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-12464--,00.html

31 <http://www.epa.ohio.gov/dsw/tmdl/ToussaintRiverTMDL.aspx>

32 <http://www.epa.ohio.gov/dsw/tmdl/SwanCreekTMDL.aspx>

33 http://www.epa.ohio.gov/dsw/tmdl/monitoring_LowerMaumeeTribs.aspx

34 http://epa.ohio.gov/dsw/tmdl/monitoring_PortageRiver.aspx

35 http://www.michigan.gov/documents/deq/wb-swas-tmdl-lapointe_214461_7.pdf

- River Raisin³⁶
- Wagner-Pink Drain³⁷

Ohio EPA Integrated Report

State environmental agencies, are required by US EPA to submit reports under Sections 303(d), 305(b), and 314 of the Clean Water Act. Ohio EPA combines these as an “Integrated Report,” which is updated every two years. It includes information on the environmental health of watershed. The environmental health of a watershed is based on several factors, which are rated in the report. Scores are based on watersheds because the land and habitat along and draining into streams has a strong and direct connection with the quality of water in a stream, that stream’s ability to support life, and provide safe recreation and water supply. These criteria are:

- Aquatic Life Use – a stream’s ability to support life
- Recreational Use – a stream’s safety for swimming, boating, or other recreation that involves contact with water
- Human Health – Potential impact of a stream and its sediments on human health by direct contact or through the food chain
- Drinking Water – quality of water for use as a public drinking water supply

Each watershed is rated for these four use categories on a score from 0 to 5: “0” being not applicable, “1” being in attainment, and “5” being impaired. The following table defines the use scores and qualifications.³⁸

36 <http://www.deq.state.mi.us/documents/deq-wb-swas-tmdl-ecoli-raisin.pdf>

37 <http://www.deq.state.mi.us/documents/deq-swq-gleas-tmdlwagnerpink.pdf>

38 <http://epa.ohio.gov/portals/35/tmdl/2010IntReport/Section%20A.pdf> page A-2 The Michigan 2010 Integrated Report is available at: http://www.michigan.gov/documents/deq/wb-swas-final-2010IR_316320_7.pdf

Table 2 Ohio Integrated Report Categories

Table A-1. Category definitions for the 2010 Integrated Report and 303(d) list.

Category ¹		Subcategory	
0	No waters currently utilized for water supply		
1	Use attaining	h	Historical data
		x	Retained from 2008 IR
2	Not applicable in new (2010) Ohio system		
3	Use attainment unknown	h	Historical data
		i	Insufficient data
		x	Retained from 2008 IR
4	Impaired; TMDL not needed	A	TMDL complete
		B	Other required control measures will result in attainment of use
		C	Not a pollutant
		h	Historical data
		n	Natural causes and sources
		x	Retained from 2008 IR
5	Impaired; TMDL needed	M	Mercury
		h	Historical data
		x	Retained from 2008 IR

¹ Shading indicates categories defined by U.S. EPA; additional categories and subcategories are defined by Ohio EPA.

The Ohio watersheds of the region are given in the following table³⁹, including their use attainment scores as reported in the *Ohio 2010 Integrated Water Quality Monitoring and Assessment Report*. Please note that this was the most recent version at time of publication. Updates are anticipated every two years; please refer to Ohio EPA's website for the most recent report.

Table 3 Northwest Ohio Watersheds and Beneficial Use Assessments

Northwest Ohio Watersheds and Beneficial Use Assessments: 2010								
10 Digit Watershed		12 Digit Watershed	Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score	
0410000103	Ottawa River-Frontal Lake Erie	041000010301	Shantee Creek	15.8	5	3	5h	0
		041000010302	Halfway Creek	39.9	5x	3	5h	0
		041000010303	Prairie Ditch	18.6	5x	3	5h	0
		041000010304	Headwaters Tenmile Creek	48.3	5x	3	5h	3i

Northwest Ohio Watersheds and Beneficial Use Assessments: 2010

10 Digit Watershed	12 Digit Watershed	Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score
	041000010305	North Tenmile Creek	40.5	5x	3	5h 0
	041000010306	Tenmile Creek	15.0	5x	3	5h 0
	041000010307	Heldman Ditch-Ottawa River	28.2	5x	3	5h 0
	041000010308	Sibley Creek-Ottawa River	22.4	5	3	5 0
	041000010309	Detwiler Ditch-Frontal Lake Erie	7.4	5x	3	5h 0
10 Digit Watershed Area Total			236.0			

0410000905	Beaver Creek-Maumee River	041000090502	Hammer Creek	25.1	5x	3	3	0
		041000090504	Upper Yellow Creek	34.6	5x	3	3	0
		041000090505	Brush Creek	25.1	5x	3	3	0
		041000090506	Lower Yellow Creek	22.7	5x	3	3	0
		041000090507	Cutoff Ditch	22.1	5x	3	3	0
		041000090508	Middle Beaver Creek	23.5	5x	3	3	0
		041000090509	Lower Beaver Creek	16.8	5x	3	3	0
		041000090510	Lick Creek-Maumee River	23.4	5x	3	3i	0
10 Digit Watershed Area Total				193.2				

0410000906	Tontogany Creek-Maumee River	041000090601	Tontogany Creek	45.3	3x	3	3	0
		041000090602	Sugar Creek-Maumee	21.7	3x	3	3	0

Northwest Ohio Watersheds and Beneficial Use Assessments: 2010

10 Digit Watershed	12 Digit Watershed	Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score		
	041000090603	River Haskins Road Ditch-Maumee River	15.7	3x	3	5	3i	
10 Digit Watershed Area Total			82.8					
0410000907	Upper Swan Creek	041000090701	Ai Creek	50.8	4A	4A	3	0
		041000090702	Fewless Creek-Swan Creek	28.3	4A	4A	3	3i
		041000090703	Gale Run-Swan Creek	16.9	4A	4A	3	0
10 Digit Watershed Area Total			96.1					
0410000908	Lower Swan Creek	041000090801	Upper Blue Creek	20.3	3i	4A	3	0
		041000090802	Lower Blue Creek	24.5	4A	4A	3	0
		041000090803	Wolf Creek	27.2	4A	4A	3	0
		041000090804	Heilman Ditch-Swan Creek	36.9	4A	4A	5	0
10 Digit Watershed Area Total			108.8					
0410000909	Grassy Creek-Maumee River	041000090901	Grassy Creek Diversion	24.8	3i	5	3	0
		041000090902	Grassy Creek	13.7	5	5	3i	0
		041000090903	Crooked Creek-Maumee River	18.9	3	5	5	0
0410000909	Grassy Creek-Maumee River	041000090904	Delaware Creek-Maumee River	19.2	5	5	5	0
10 Digit Watershed Area Total			76.6					
0410001001	Rocky Ford-Middle Branch Portage River	041000100101	Rader Creek	32.7	5	5	3i	3i
		041000100102	Needles Creek	31.4	5	5	3	0

Northwest Ohio Watersheds and Beneficial Use Assessments: 2010

10 Digit Watershed	12 Digit Watershed		Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score
	041000100103	Rocky Ford Town of Rudolph-	73.5	5	5	3i	3i
	041000100104	Middle Branch Portage River	31.1	1	5	3i	0
10 Digit Watershed Area Total			168.8				

0410001002	South Branch Portage River- Middle Branch Portage River	041000100201	Bull Creek	30.5	5	5	3	0
		041000100202	East Branch Portage River	36.2	5	5	5	3i
		041000100203	Town of Bloomdale- South Branch Portage River	53.6	5	5	3i	3i
		041000100204	Rhodes Ditch-South Branch Portage River	20.7	1	5	3i	0
		041000100205	Cessna Ditch- Middle Branch Portage River	25.4	1	5	3i	0
		10 Digit Watershed Area Total			166.3			

0410001003	Upper Portage River	041000100301	North Branch Portage River	64.4	5	5	5	0
		041000100302	Town of Pemberville- Portage River	18.1	1	5	5h	0
10 Digit Watershed Area Total			82.5					

0410001004	Middle Portage	041000100401	Sugar Creek	59.4	5	5	5h	0
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Northwest Ohio Watersheds and Beneficial Use Assessments: 2010

10 Digit Watershed	12 Digit Watershed	Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score
	River					
	041000100402	Lacarbe Creek Outlet #4-Portage River	27.9	5	5	5h 0
10 Digit Watershed Area Total			87.3			
0410001005	Lower Portage River-Frontal Lake Erie					
	041000100501	Little Portage River	32.6	5	5	5h 0
	041000100502	Portage River	48.9	5	5	5 0
	041000100503	Lacarbe Creek-Frontal Lake Erie	40.3	3	3	5h 0
10 Digit Watershed Area Total			121.8			
0410001006	Toussaint Creek					
	041000100601	Upper Toussaint Creek	74.0	4Ax	5	5h 0
	041000100602	Packer Creek	34.5	4Ax	3	5h 0
	041000100603	Lower Toussaint Creek	30.7	4Ax	3	5 0
10 Digit Watershed Area Total			139.1			
0410001007	Cedar Creek-Frontal Lake Erie					
	041000100701	Turtle Creek-Frontal Lake Erie	40.7	5	5	3 0
	041000100702	Crane Creek-Frontal Lake Erie	56.5	5	5	3 0
	041000100703	Cedar Creek-Frontal Lake Erie	58.0	5	5	3 0
	041000100704	Wolf Creek-Frontal Lake Erie	15.2	3i	5	3 0
	041000100705	Berger Ditch	16.1	5	5	3 0
	041000100706	Otter Creek-Frontal Lake Erie	18.1	5	5	3i 0

Northwest Ohio Watersheds and Beneficial Use Assessments: 2010

10 Digit Watershed	12 Digit Watershed	Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score
10 Digit Watershed Area Total			204.5			
0410001101	Mills Creek-Frontal Lake Erie 041000110103	Mills Creek 42.2	5hx	3	3	3i
10 Digit Watershed Area Total			42.2			
0410001102	Pickrel Creek-Frontal Sandusky Bay 041000110201	Frontal South Side of Sandusky Bay 43.4	5hx	3	3	0
	041000110202	Strong Creek 15.9	5hx	3	3	0
	041000110203	Pickrel Creek 48.5	5hx	3	3	0
	041000110204	Raccoon Creek 34.4	5hx	3	3i	1
	041000110205	South Creek 22.0	5hx	3	3	0
10 Digit Watershed Area Total			164.2			
0410001110	Wolf Creek 041000111003	Snuff Creek-East Branch Wolf Creek 29.2	3x	3i	3	0
	041000111004	Wolf Creek 73.5	3x	3i	3	0
10 Digit Watershed Area Total			102.7			
0410001111	Rock Creek-Sandusky River 041000111105	Spicer Creek-Sandusky River 30.9	4Ax	3	3	0
10 Digit Watershed Area Total			30.9			
0410001112	Green Creek 041000111202	Beaver Creek 29.3	3x	3	3	3i
	041000111203	Green Creek 30.8	3x	3	1	3i
10 Digit Watershed Area Total			60.1			
0410001113	Muskellunge Creek-Sandusky River 041000111301	Muskellunge Creek 46.3	3x	3	3	0
	041000111302	Indian Creek-Sandusky River 37.6	3x	3	5	0
	041000111303	Mouth Sandusky River 24.9	3x	3	3	0

Northwest Ohio Watersheds and Beneficial Use Assessments: 2010

10 Digit Watershed	12 Digit Watershed	Area, Square Miles	Aquatic Life Use Score	Recreational Use Score	Human Health Score	Drinking Water Score
10 Digit Watershed Area Total		108.8				
0410001114 Muddy Creek-Frontal Sandusky Bay	041000111401 Gries Ditch	13.9	3x	3	3	0
	041000111402 Town of Helena-Muddy Creek	45.2	3x	3	3	0
	041000111403 Little Muddy Creek	28.6	3x	3	3	0
	041000111404 Town of Lindsey-Muddy Creek	24.1	3x	3	3	0
	041000111405 North Side Sandusky Bay Frontal	26.5	3x	3	3	0
	10 Digit Watershed Area Total		138.4			

The Ohio EPA 2010 Integrated Report web page provides extensive and detailed information on each 12 digit watershed. The information includes land use in the watershed, the stream’s use designations (which affect effluent quality standards for NPDES permits), causes and sources of water quality and habitat impairment, and whether the stream is on OEPA’s watch list for nitrates or pesticides.⁴⁰

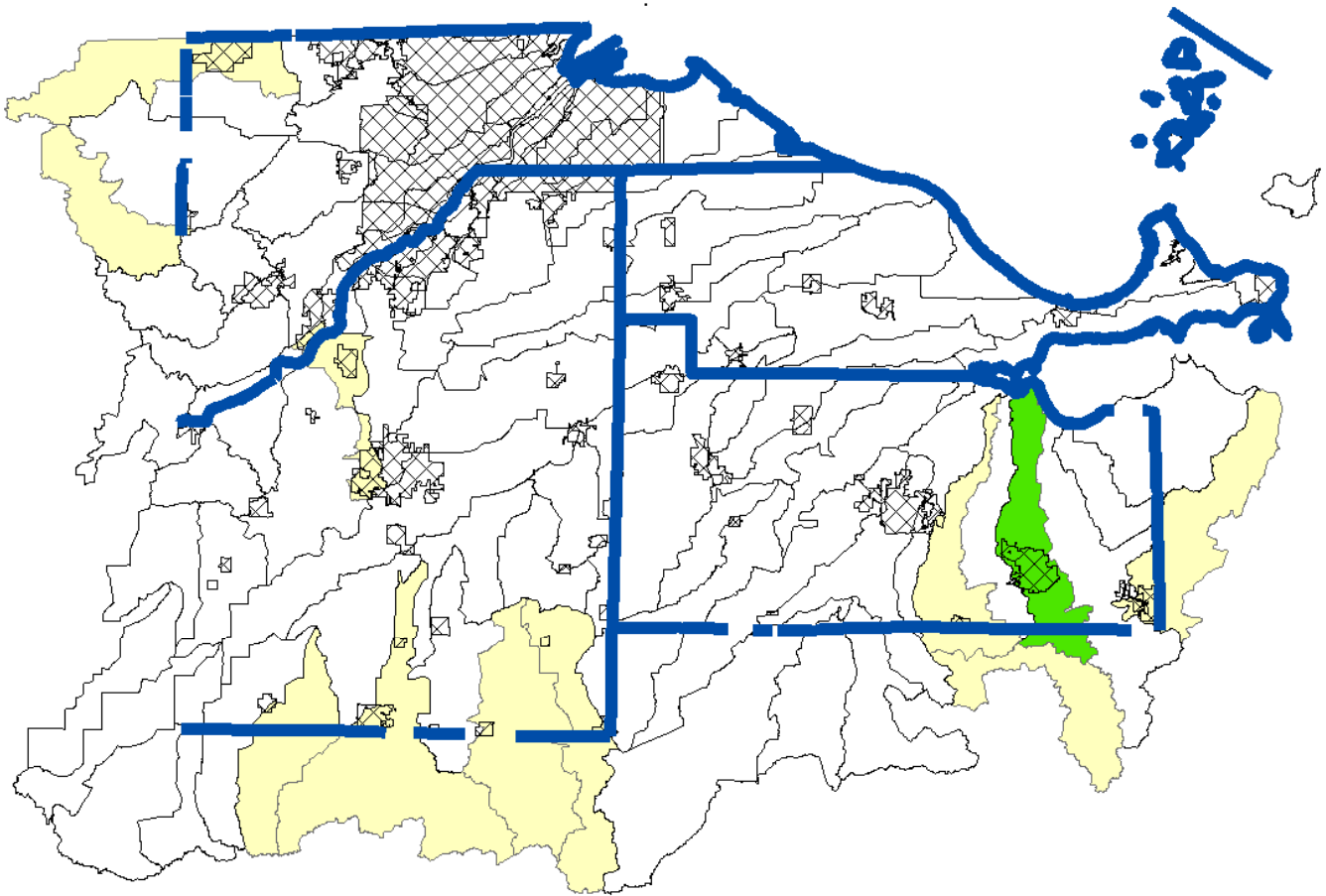
Ohio EPA Integrated Report data illustrates the beneficial use status of each watershed. The following maps show the use scores to summarize overall water quality of northwest Ohio streams.⁴¹

Watershed Attainment: Public Drinking Water Supply

The first map shows water quality attainment for the purpose of public drinking water supply. Most of the watersheds are blank, because there are no public water supplies in these watersheds. Several municipalities in Sandusky County, central and southern Wood County, and western Lucas County draw water from streams and use offline reservoirs. All but one of these source watersheds rate unknown attainment, meaning the watersheds have not been assessed. One watershed is shown in attainment, in which the City of Clyde is located.

⁴⁰ <http://wwwapp.epa.ohio.gov/dsw/ir2010/basin.php>

⁴¹ <http://wwwapp.epa.ohio.gov/dsw/ir2010/basin.php> data files were used without modification to prepare these maps. For clarity, subcategories have been combined — i.e., watersheds rated “5M”, “5h”, or “5x” are simply shown as “5”.



Watershed Use Attainment Drinking Water



0 2.5 5 10 15 20 25 Miles

Legend

 Municipalities

Assessment - Drinking Water

Drinking Water Attainment

 No Water Supply

 Attaining

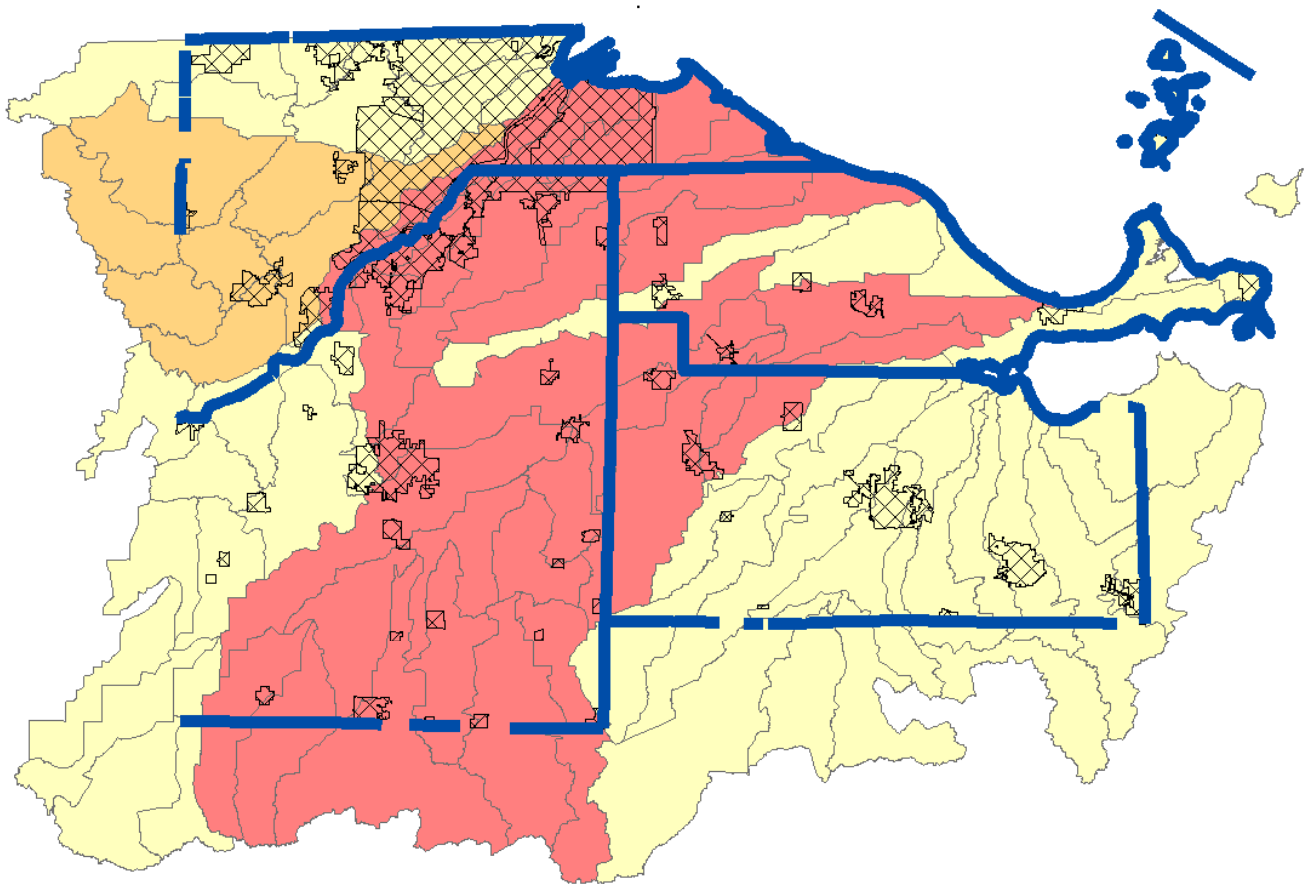
 Unknown



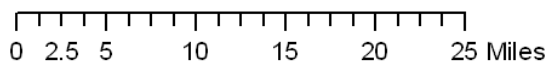
Figure 7 Watershed Use Attainment: Drinking Water

Watershed Attainment: Recreation

Watershed use attainment for recreation is based principally on bacterial contamination, which is measured by the concentration of *E. coli* bacteria found in the water. Roughly half of the watersheds in the region are impaired for recreation, and the other half have not been assessed. None of the watersheds in the region are in attainment.



Watershed Use Attainment Recreation



Legend






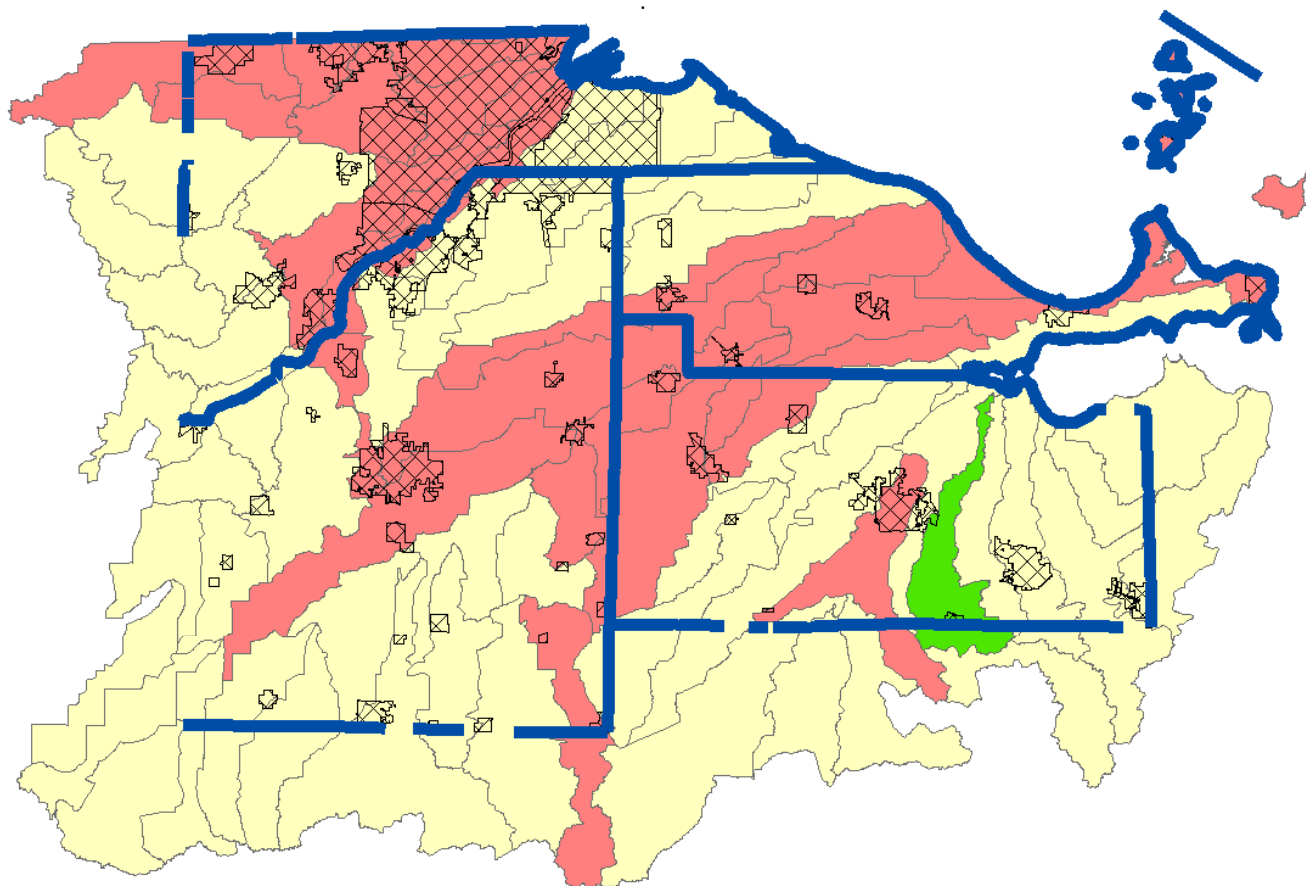
-  Municipalities
- Assessment - Recreation**
- Recreation Attainment**
-  Attaining
-  Unknown
-  Impaired - TMDL not needed
-  Impaired - TMDL needed

Figure 8 Watershed Use Attainment: Recreation

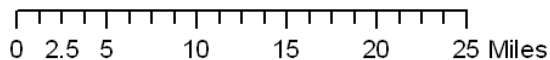
Watershed Attainment: Human Health

Human health use attainment for a watershed is based on potential public exposure to carcinogenic and non-carcinogenic chemicals in water, sediments, and sport fish. Chemicals of concern include PCBs, mercury, DDT, chlordane, hexachlorobenzene, and mirex.⁴² Section “E” of the 2010 Integrated Report lists which contaminants were found in each impaired watershed. For nearly all of the impaired watersheds of northwest Ohio, the chemical of concern is PCBs; one watershed also lists mercury. Roughly a third of watershed area of the region is impaired with respect to human health. For the majority of other areas, the streams have not been assessed, and attainment status is not known. One watershed, in Sandusky and Seneca Counties, is

shown in attainment.



Watershed Use Attainment Human Health



- Legend**
- Municipalities
 - Assessment - Human Health**
 - Human Health Attainment**
 - Attaining
 - Unknown
 - Impaired - TMDL Needed

Figure 9 Watershed Use Attainment: Human Health

Watershed Attainment: Aquatic Life

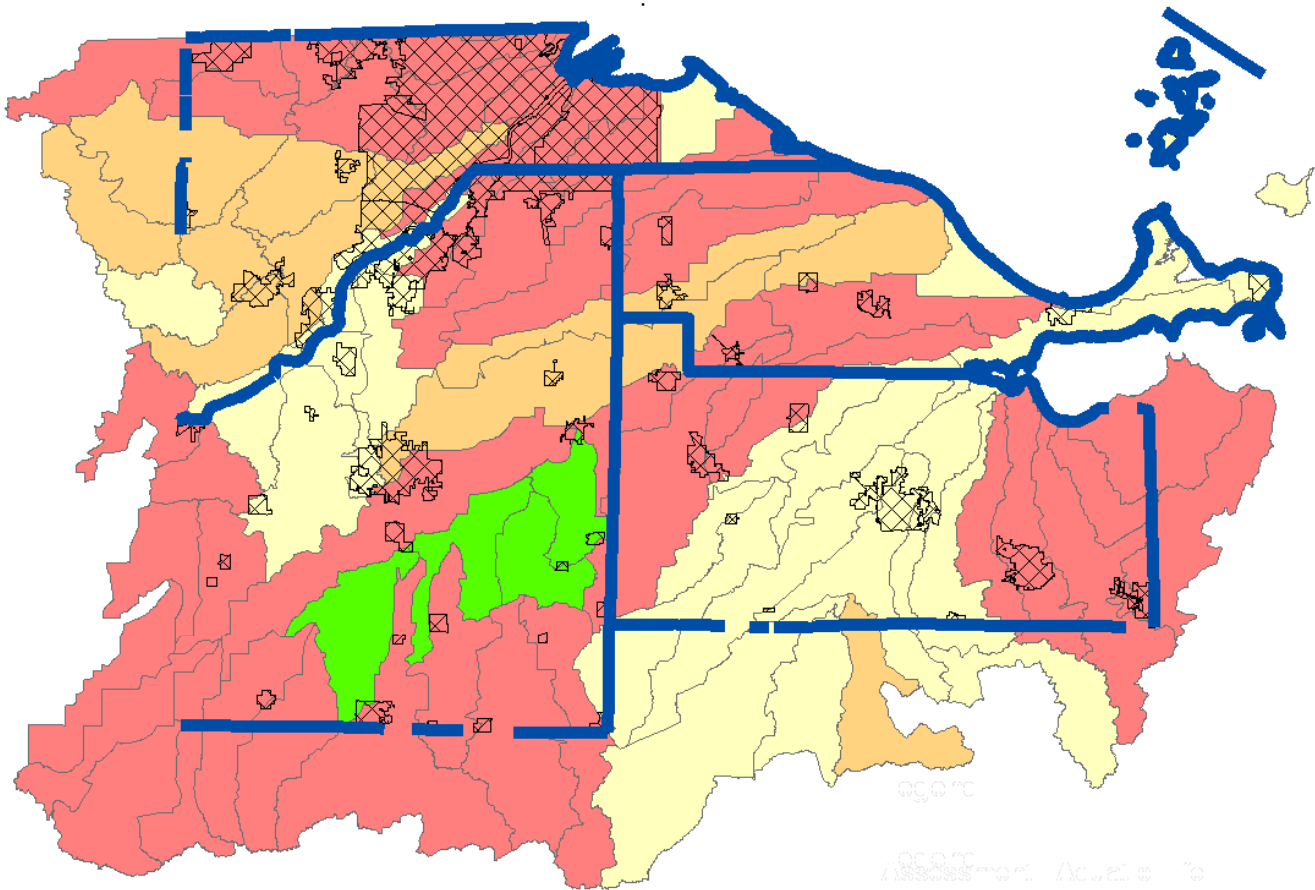
Aquatic Life rates a watershed’s ability to provide habitat and support fish and macroinvertebrates (insect larvae, crustaceans, mollusks, worms, and other organisms at the base of the food chain). More than the other use attainment categories, aquatic life is dependent on the land draining into the stream. Use attainment is made by surveying a stream to determine the number of organisms, the number and diversity of species, and whether those species are pollution sensitive or pollution tolerant. If only a few species of

fish live in a stream, and they are all pollution tolerant, it is an indication that the stream is polluted. Land use, especially riparian habitat, plays a crucial role in protecting streams from nonpoint source pollution, and supporting life in the stream.

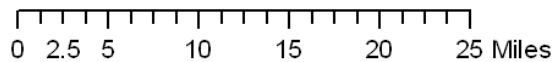
The top five causes of impairment for the aquatic life use for the period 1999 through 2008⁴³ are

- Siltation/sediment
- Nutrients
- Habitat modification
- Hydromodification
- Organic enrichment / dissolved oxygen (DO).

More than half of the region's watershed area is impaired with respect to aquatic life; the top five causes of impairment that Ohio EPA cites are typical to northwest Ohio streams. Of watersheds not classified as impaired, most have not been assessed. The only watersheds in the region in attainment with aquatic life standards are tributaries of the Portage Middle Branch in south-central and southeast Wood County.



Watershed Use Attainment Aquatic Life








- Legend**
-  Municipalities
 - Assessment - Aquatic Life**
 - Aquatic Life Attainment**
 -  Attaining
 -  Unknown
 -  Impaired - TMDL not needed
 -  Impaired - TMDL needed

Figure 10 Watershed Use Attainment: Aquatic Life

Groundwater

Understanding the groundwater of the region begins with bedrock, and the overlying layers of gravel, sand, silt, and clay left behind by glaciers and glacial lakes. Most of the bedrock in the region is dolomite, a magnesium-bearing form of limestone. There are a number of different layers of dolomite in the region, of different ages and chemical compositions. These differences result in differing commercial uses and values; physical strength; and presence, depth, and quality of groundwater. There are smaller areas of sandstone and shale, notably in northwestern Lucas County. Several reports present extensive information about the geology and hydrogeology

of the region^{44,45,46, 47} .

The soils and terrain of the region result from the advance and retreat of glaciers and glacial lakes. Between 14,000 and 12,200 years ago glaciers advanced and retreated across Ohio at the end of the Ice Age. During this time a series of lakes covered what is now the Lake Erie basin, at elevations ranging from 640 to 800 feet. Lake Erie came into existence about 12,000 years ago at an elevation of about 492 feet, compared with today's level at 571 feet. The glacial lakes, starting with the oldest, are known to geologists as Lakes Maumee, Arkona, Ypsilanti, Whittlesey, Warren, Wayne, Grassmere, Lundy, and Erie. Lake bottoms left behind flat silt-clay deposits that became the Great Black Swamp. Former beaches are now sand ridges, and retreating glaciers left behind moraines.⁴⁸

Roughly 100,000⁴⁹ of the region's 716,000 residents in 2000 used private wells for drinking water. In addition, eleven villages supply public water from wells. Though the number of residents using groundwater has declined over the years, it remains an important source of drinking water, both for public systems and private wells. The depth of soil or till to bedrock varies widely. In some buried valleys, the depth to bedrock exceeds 100 feet. In other areas, scattered throughout the region, the bedrock is at the surface.⁵⁰

Groundwater is pumped from aquifers in bedrock or glacial till. Except for the shale of northwest Lucas County and southwestern Monroe County, nearly all the bedrock in the region is dolomite, a magnesium-bearing form of limestone. Shallow wells draw water from sand, gravel, or soil overlying the bedrock. This shallow aquifer tends to be softer than water from a bedrock aquifer, but is more susceptible to contamination from the surface. Since most of the bedrock in the region is limestone or dolomite, water drawn from it is said to come from the carbonate aquifer.

Dolomite is quarried in several parts of the region for crushed stone and concrete aggregate. In eastern Ottawa County there are inactive gypsum quarries. In some areas the rock is pure limestone, and is quarried for cement or agricultural lime.

Dolomite is naturally, if slowly, soluble in water. Some types form underground cavities or caves over time. In some areas the solution cavities erode the bedrock, and the soil collapses in from above. Collapsed cavities in the bedrock are called sinkholes, and this type of geologic structure is referred to as a Karst formation. There are two karst formations in the region: in eastern Sandusky County⁵¹, and in Monroe County⁵². Sinkholes are a threat to groundwater quality because they are a place where surface pollutants can quickly and easily enter. Karst formations are of concern because groundwater moves through a karst area very quickly compared to other types of bedrock. Contaminants entering a karst formation can move hundreds of feet per day.

44 *Study of Physical Features for the Toledo Regional Area*, TRAPA, Dr. Jane Forsyth 1968

45 *Ground Water for Planning in Northwest Ohio: A Study of the Carbonate Rock Aquifers* Ohio Water Plan Inventory Report Number 22, ODNR Division of Water 1970.

46 *Groundwater Management Strategies as part of the Baseline Report* TMACOG 1984

47 *Geohydrology and Quality of Water in Aquifers in Lucas Sandusky & Wood Counties Northwestern Ohio* US Geological Survey (USGS), Breen & Dumouchelle, 1991

48 *Lake Erie and Lake St. Clair Handbook*, Stanley J. Bolsenga and Charles E. Herdendorf, Wayne State University Press, 1993 page 71

49 Based on population with available sanitary sewers in the FPA GIS system. This should be taken as an "order of magnitude" figure, since there are areas with sewers but not water, and areas with water but no sewer. Water user figures are not readily available.

50 *A Study of Physical Features for the Toledo Regional Area*, the Toledo Regional Area Plan for Action (TRAPA); Bowling Green State University Geology Department, Dr. Jane Forsyth; March 1968, chapter IV

51 *Karst Unified Source Water Protection Plan*, WSOS Community Action Commission, March 2001

52 *Geology for Environmental Planning in Monroe County, Michigan*, Andrew J. Mozola, Wayne State University; Michigan Department of Natural Resources, Geological Survey Division, 1970

Generally the region's groundwater is safe for drinking. Where wells are contaminated, the contamination is localized. A few of the sources of potential contamination are surface runoff entering the ground through a sinkhole or well casing, septic systems, or underground storage tanks. Generally speaking, a pollutant on the ground that has a water pathway into the soil has the potential to contaminate drinking water. Safe drinking water is usually measured by concentrations of fecal bacteria, which would indicate the presence of sewage or manure; or nitrate concentrations over 10 mg/l. Chapters 5 and 6 discuss the human health impacts of nitrates, known as Methemoglobinemia, or "blue baby syndrome". In many parts of the region raw groundwater is undesirable for drinking and other household uses because of high levels of hardness, iron, and sulfur. Some form of treatment, therefore, is typically necessary when using this important source of water.

Two studies of private well water quality have been conducted. In 1985-1988 the US Geological Survey (USGS) studied groundwater quality in Lucas, Wood, and Sandusky Counties by testing 135 wells and 11 springs for 52 parameters. The study found 36 of 125 well samples unsafe based on total coliform bacteria counts (4 or more colonies per 100 ml). Two well samples exceeded the safe nitrate level of 10 mg/l.⁵³

The National Center for Water Quality Research (NCWQR) at Heidelberg University surveys private well water quality by offering well tests at an affordable cost. The program started in 1987 and still continues. Tests cover nitrate and other inorganic chemicals, metals, pesticides, and volatile organic compounds. The NCWQR notes, "The results of the program indicate that the extent of nitrate contamination varies greatly from county to county. Many agricultural counties have very little nitrate contamination in private wells, while other counties have considerable contamination. As of April 2010, 56,000 wells have been tested nationwide. Slightly less than half of the wells tested are from Ohio. No trace of nitrate contamination was found in 66.3% of the wells. In 4.2 % of the wells, nitrate concentrations exceeded the drinking water standard of 10 mg/l (ppm). Atrazine in excess of its drinking water standard of 3.0 ppb has been found in only 0.3 % of the 21,922 wells tested."⁵⁴ An older Heidelberg College study⁵⁵ analyzed water quality in private wells by county in Ohio. More information on the NCWQR well testing program is available at its website⁵⁶.

Table 4 Private Well Water Quality

County	Private wells tested (1988)	Percent of wells over 10 mg Nitrate per liter	Average Nitrate concentration, mg/l
Lucas	183	2%	0.65
Ottawa	184	4%	0.22
Sandusky	183	5%	0.71
Wood	81	4%	0.99

In some cases septic system failures have contaminated many private wells in an area. In Catawba Island Township of Ottawa County⁵⁷, and the Stearns Crest/Flechtner Heights⁵⁸ subdivisions near Fostoria, well

⁵³ *Geohydrology and Quality of Water in Aquifers in Lucas, Sandusky, and Wood Counties, Northwestern Ohio US Geological Survey Water-Resources investigations Representative 91-4024, 1991. Pages 2, 74-5, and Table 9*

⁵⁴ Personal communication from the National Center for Water Quality Research, April 7, 2010

⁵⁵ *Nitrate and Pesticides in Private Wells of Ohio: a State Atlas*, Heidelberg College Water Quality Laboratory,

⁵⁶ <http://ncwqr.heidelberg.edu/waterTesting.html>

⁵⁷ *Port Clinton Ohio Facilities Plan Addendum for Catawba Island Portage Townships*, Finkbeiner Pettis & Strout July 1987

⁵⁸ *Study of the Effects of Domestic Sewage on Ground Water Quality in Stearns Crest Subdivision Wood County Ohio*

Dept of Health, 1982

contamination led to the installation of sanitary sewers. In Chapter 4, the Facility Planning Area descriptions note areas with groundwater contamination due to failed septic systems.

Advisories

When consumption of fish, or contact with water or stream sediments, may endanger public health, a regulatory agency may issue an advisory. It is advice to the public not to eat certain types of fish, or not to swim in certain streams.⁵⁵

In Ohio, fish consumption advisories are issued by the Ohio Department of Health and Ohio EPA. Current advisories and additional references are available on the web.^{59, 60} They advise not eating certain types of fish from some streams, or limiting how often you eat certain types of fish. A summary of the advisories is given below. Please refer to the Ohio EPA website for a current and complete listing.

Table 5 Fish Consumption Advisories

Water Body	Fish Consumption Advisory	Contaminants
Lake Erie	Limits on consumption of about a dozen fish species of one meal/month	PCBs; for rock bass, bullmouth bass, and largemouth bass – also mercury
Lake Erie	One meal every two months of channel catfish, carp over 27” long, and lake trout	PCBs
Lake Erie	One meal every two months of rock bass, brown bullhead, and largemouth bass	PCBs and/or mercury
Lake Erie tributaries: Lucas, Ottawa, Sandusky Counties	Steelhead Trout, one meal / month	PCBs
Maumee River	Limits on consumption of Freshwater Drum, Smallmouth Bass to one meal / month	PCBs
Maumee River	Limits on consumption of channel catfish of one meal / 2 months	PCBs
Maumee River	Limits on consumption of Smallmouth Buffalo to 1 meal / month	PCBs, mercury
Maumee River	Limits on consumption of Common Carp, Flathead Catfish to one meal / month	Mercury
Maumee River	Limits on consumption of snapping turtles to one meal / week	Mercury
Ottawa River (I-475 @ Wildwood to mouth)	Advisory against eating any fish or snapping turtles	PCBs
Ottawa National Wildlife Refuge – all waters	Limits on consumption of snapping turtles to one meal / week	Lead
Portage River Ohio Turnpike to Lake Erie	Limits on consumption of Channel Catfish, Common Carp of 1 meal in 2 months	PCBs
Sandusky River, Bucyrus to Fremont	Limits on consumption of largemouth bass, and channel catfish 16” and larger of one meal per month	Mercury and/or PCBs
Sandusky River, Bucyrus to Fremont	Limits on consumption of carp of one meal per month	PCBs
Sandusky River Fremont to mouth	Limits on consumption of largemouth bass, and channel catfish 16” and larger of one meal per month	Mercury, PCBs

59 index to Ohio advisories is available at <http://epa.ohio.gov/dsw/fishadvisory/index.aspx> with links to fish consumption and swimming advisories, fact sheets, advisory information for sensitive populations, and fish trimming and cooking tips.

60 <http://epa.ohio.gov/dsw/fishadvisory/turtles.aspx>

When a river is judged unsafe for swimming or wading, a regulatory agency posts an advisory. It is advice to the public to avoid physical contact with the waters of these streams. Ohio EPA and the Ohio Department of Health jointly issue advisories due to contaminants. Local Boards of Health may also post advisories due to fecal contamination. Long term swimming advisories in the region are given below.

Table 6 Swimming Advisories

Water Body Do Not Swim Advisory	Issued by	Reason
Ottawa River (I-475 @ Wildwood to mouth)	Ohio EPA and Ohio Department of Health	PCBs
Ottawa River	Toledo/Lucas County Health Department	Fecal bacteria

The Ohio Department of Health conducts a beach testing program.⁶¹ Public swimming beaches are tested regularly throughout the season for fecal contamination, based on concentrations of *E. coli*. When bacteria levels at a beach exceed standards, an advisory is posted. The advisory is taken down or re-posted as tests warrant throughout the summer. The region’s public bathing beaches are listed below.^{62, 63}

Table 7 Public Bathing Beach

Public Bathing Beach	County
Maumee Bay State Park	Lucas
Camp Perry	Ottawa
Port Clinton City Beach	Ottawa
Catawba Island	Ottawa
South Bass Island State Park	Ottawa
East Harbor State Park	Ottawa
Lakeside	Ottawa
Luna Pier Beach	Monroe
Covered Wagon Campground Pond	Monroe
The Vine campground pond	Monroe

Lake Erie Water Quality

Phosphorus, “Toxic Algae” Blooms and Dead Zones

All water in the region flows to Lake Erie, and that is the ultimate resource we seek to protect and enhance for the benefit of the region and its citizens. In the late 1960s national headlines heralded the death of Lake Erie, and talked about the Cuyahoga River catching fire. Industrial waste was part of the problem, but the fact that a river could catch fire was an effect, not the cause of, Lake Erie’s dying.

“Eutrophic” is a term that describes a lake enriched with nutrients (phosphates and nitrates) and organic matter. That enrichment results in increasing biological productivity. In the case of Lake Erie, the eutrophication process has been accelerated by its over-nourishment. Studies in the 1970s and early 1980s identified phosphate as the critical nutrient for eutrophication: the amount of available phosphorus controls algae growth, and phosphate entering Lake Erie dictated the rate of eutrophication.

For Lake Erie, “over-nourishment” meant accelerated nuisance growths (blooms) of cyanobacteria. These

61 Ohio Department of Health Beach Monitoring Sample Results, http://www.odh.ohio.gov/odhPrograms/eh/bbeach/beach_samplemonitoring.aspx

62 “Bathing Beach Monitoring Program Guidelines,” Ohio Department of Health Bureau of Local Services, 1996

63 <http://www.deq.state.mi.us/beach/>
C:\WQ\AWQMPI\PLAN\AWQMP1.DOC

cyanobacteria are photosynthetic, also called blue-green algae.⁶⁴ Their blooms are still popularly called “toxic algae.” The immediate effect was to make Lake Erie an unpleasant recreation area because of the cyanobacteria’s strong odor. Over the following winters, the mass of cyanobacteria would die and sink to the bottom of the lake. The following season, the dead cyanobacteria would decay at the bottom of the lake, and deplete oxygen dissolved in the water. Fish and other aquatic life also need oxygen. Areas of the lake without oxygen are called “dead zones” because fish can’t live there. The bigger the dead zones, the worse the impact on Lake Erie fish.

In 1983 the US and Canada ratified Annex III of the Great Lakes Water Quality Agreement. Based on studies conducted in the 1970s, this agreement called for the reduction of annual phosphorus loading to 11,000 metric tons to achieve Clean Water Act goals. These loadings were estimated to be necessary to eliminate the “algae” blooms and the resulting dead zones⁶⁵. As discussed below, more recent studies may focus phosphorus controls on dissolved phosphorus. Nonetheless, these early studies were the basis of policies that did improve water quality in the ‘80s and ‘90s. The total identified 11,000 ton reduction of phosphorus loading was allocated among the watersheds, and split between point and non-point source loadings. Ultimately the required non-point source reductions were assigned to individual counties, with targets for agricultural and urban runoff reductions. The phosphorus reduction targets for our region were⁶⁶:

Table 8 Phosphorus Reduction Targets

Tributary	Point Source Phosphorus Reduction Target, metric tons per year	Non-Point Source Phosphorus Reduction Target, metric tons per year	Total Phosphorus Reduction Target, metric tons per year
Ottawa	0.0	74.2	74.2
Maumee (the 74% in Ohio)	22.5	2,113.3	2,335.8
Portage / Toussaint	13.7	535.1	548.8
Sandusky	44.1	711.4	755.5

Public agencies took a number of steps in the 1980s and 1990s to achieve these reductions in the amount of phosphorus entering Lake Erie:

- The discharge permit requirements for sewage treatment plants were strengthened. Phosphorus discharges were reduced to 1.0 mg/l for treatment plants discharging over 1 million gallons per day.
- The Ohio legislature banned phosphorus from laundry detergents sold in the Lake Erie drainage area (includes all of the TMACOG region)
- Sanitary sewers have eliminated thousands of septic systems. In the TMACOG region numerous small communities have public sewers that did not in 1982. All these communities had documented water pollution problems due to septic systems.
- Agricultural agencies and the county Soil and Water Conservation Districts promoted conservation tillage, buffer strips, and other Best Management Practices to reduce phosphorus runoff from farmland. Financial incentives have encouraged these practices through programs such as the Conservation Reserve Enhancement Program and the EPA “319” nonpoint source program. These

64 Personal communication: Dr. Thomas B Bridgeman, PhD., University of Toledo Lake Erie Center, February 2004

65 *Ohio Phosphorus Reduction Strategy for Lake Erie | Ohio Water Quality Management Plan* Ohio EPA Office of The Planning Coordinator, June 1985, page 1

66 *Ohio Phosphorus Reduction Strategy for Lake Erie | Ohio Water Quality Management Plan* Ohio EPA Office of The Planning Coordinator, June 1985, page 5

incentives are discussed in Chapter 6.

- US EPA established the NPDES Stormwater Permit program. It requires urban jurisdictions to identify and control pollution from urban runoff. Large cities were required to apply for permits by 1998, and smaller jurisdictions in urban areas by 2003. The NPDES Stormwater program also regulates construction sites that disturb more than an acre of land. Chapter 7 discusses Stormwater permit regulations.

Throughout the 1980s and 90s the water quality of Lake Erie improved. The dead zones were greatly reduced, and the fish populations recovered.

In the 1990s Zebra Mussels spread throughout Lake Erie and changed the balance. These small filter feeders were accidentally introduced from eastern Europe. They thrived in Lake Erie and its tributaries, encrusting boats, docks, water intakes, and everything else in the shallow waters. They certainly made the lake clearer and more attractive. They did not make the lake cleaner, but they did change the routing of nutrients through the ecosystem. Their ecological impact is still not completely understood.

In 2002 and 2003 the dead zone reappeared in the Central Basin of Lake Erie, and the “toxic algae” bloom returned. “Toxic algae” extended into the Western Basin and Maumee Bay. The question is, what has happened in Lake Erie that the actions taken in the ‘80s and ‘90s are no longer having their full effect? There are many theories, but no conclusive answers yet.

In 2002 the International Joint Commission discussed the issue in its biennial report on Great Lakes Water Quality:

Twenty-five years ago, numerous scientific studies conducted by the Commission’s Pollution From Land Use Activities Reference Group resulted in the Parties adopting policies and programs to manage phosphorus for each lake basin through a variety of point and nonpoint source control measures. This linkage of science and policy resulted in programs to reduce phosphorus loads to the Great Lakes based on reduction targets as set out in Annex 3. The achievement of a target load for each lake is currently represented by a specific outcome: concentrations of phosphorus in the open waters. For lakes Superior, Huron, Michigan and Ontario, concentrations indicate that progress has been sustained. In the case of Lake Erie, however, open water concentrations of phosphorus often exceed the guideline, indicating that phosphorus is being released into the lake by sources or processes not fully understood. ...

Major tributaries to Lake Erie, such as the Maumee River, have achieved notable decreases in suspended sediment discharges and reductions in phosphorus loads as a result of improved agricultural practices. However, these tributaries are still very large sources of phosphorus with year-to-year loads varying with the frequency and intensity of flooding. For example, phosphorus stored in the sediment of tributaries can build up during dry or average rainfall years and can serve as a substantial load to the lake during a single flood event. Such major events could become common in the Great Lakes as a result of climate change, adding a further management challenge to achieving target loads.⁶⁷

In 2007, Ohio EPA convened its Ohio Lake Erie Phosphorus Task Force “to identify and evaluate potential point and nonpoint sources of phosphorus to Ohio tributaries; determine what practices may have changed since 1995 that could increase DRP loads; examine various aspects of agriculture that might influence the increase in DRP loads; review the possible/probable relationships of the increased DRP loads to the eutrophication problems that have returned to Lake Erie (particularly the western

⁶⁷ Eleventh Biennial Report on Great Lakes Water Quality International Joint Commission September 2002, pp 50-51

basin); consider the impacts of zebra and quagga mussels in altering the internal cycling of phosphorus in the lake itself; determine if these issues were unique to Lake Erie or occurring on a broader basis; identify research and monitoring needs; and recommend management actions that could be implemented to alleviate current conditions.”⁶⁸ The Task Force issued its final report in 2010. Below is part of the Task Force’s assessment of current phosphorus loadings to Lake Erie, and needed direction for research.

The relationship between external phosphorus loading to Lake Erie and in-lake conditions determined in the 1980s was based on total phosphorus loading to the lake, even though substantial portions of the nonpoint load were not considered to be bioavailable to Lake Erie algae. Most nonpoint-derived phosphorus is attached to suspended sediments and only about 25- 30% of this particulate phosphorus is available for supporting algal growth. Furthermore, portions of this particulate phosphorus may be physically removed from possible transfer to algae as sediments settle to the bottoms of river mouths, bays and the Lake itself. In contrast, the dissolved reactive phosphorus component of nonpoint runoff is 100% bioavailable and is delivered directly into Lake or bay water during storm runoff events.

Recent reviews of phosphorus loading to Lake Erie from Ohio tributaries have shown that trends in soluble reactive phosphorus loading differ greatly from trends in particulate phosphorus loading. Nonpoint phosphorus control programs focused on reducing particulate phosphorus loading through erosion control measures and use of buffer strips to trap sediments. The tributary loading data illustrate the success of these programs in reducing particulate phosphorus. The reviews show that dissolved reactive phosphorus loading decreased even more rapidly than particulate phosphorus up through the mid-1990s. Since that time, however, dissolved reactive phosphorus loading has increased dramatically to the point where it now is approaching the same loads as in the late 1970s and early 1980s. Algal trends in Lake Erie appear to match the trends in dissolved reactive phosphorus loading much more closely than they match the trends in either total phosphorus or particulate phosphorus loading.

In view of the above information, the Ohio EPA is proposing to form a Phosphorus Task Force to more formally review the phosphorus loading data from Ohio tributaries to Lake Erie, to consider possible relationships between trends in dissolved reactive phosphorus loading and inlake conditions, to determine possible causes for increased soluble phosphorus loading, and to evaluate possible management options for reducing soluble phosphorus loading.⁷⁰

Nutrients, Habitat, and Water Quality

Phosphorus is considered the critical nutrient where Lake Erie is concerned, but “algae blooms” also require nitrates. Concern over nitrate usually centers on its drinking water impacts, but does it also control algae growth? The question is important to public policy. Nitrates are soluble in water, so controlling nitrates means controlling water. Phosphorus attaches to sediment, so controlling phosphorus means controlling sediment. What should be the priorities of environmental agencies?

Ohio EPA discusses the critical factors of whether streams are likely to meet water quality standards.⁷¹

- Streams in the Huron-Erie Lake Plains and its neighboring Eastern Corn Belt Plains eco-regions have the highest background levels of phosphorus and nitrate [pages 1-2].

⁶⁸ http://www.epa.state.oh.us/portals/35/lakeerie/ptaskforce/Task_Force_Final_Report_April_2010.pdf

⁷⁰ <http://epa.ohio.gov/portals/35/lakeerie/ptaskforce/RationaleforWorkGroupformation.pdf>

⁷¹ *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* Ohio EPA Technical Bulletin MAS/1999-1-1, 1999

- Small streams with low phosphorus levels have the best aquatic communities, and therefore are more likely to meet water quality standards. As phosphorus levels rise, the aquatic community quality decreases [2].
- Habitat is a critical part of the stream environment. Best Management Practices to reduce erosion without considering habitat will not restore aquatic life to meet water quality standards, even though overall sediment and nutrient loadings may be reduced. Stream projects should restore the riparian functions that are lost when streams are channelized [3].
- Along streams where habitat has been irretrievably modified, habitat controls whether that stream meets water quality standards, rather than nutrient loadings [3].
- In streams and rivers phosphorus is more often a limiting factor in algal growth than nitrate [24].
- Nitrate is less frequently the limiting nutrient in algal growth. Nitrate levels only affect stream aquatic life scores in headwater streams with high nitrate levels (i.e., medians above 3-4 mg/l) [2, 29].

Our conclusion is that our primary focus needs to be reduction of sediment and phosphorus, but in conjunction with stream habitat restoration. Additional efforts to nitrate control may be needed for small streams with high average nitrate levels. Nitrate levels over 3-4 mg/l are not uncommon.

For bays and Lake Erie, research and policy emphasizes phosphorus and sediment reduction to control nuisance “algae blooms” and protect aquatic habitat. Continuing research could change those priorities.

The Heidelberg College Water Quality Lab conducts a Lake Erie Tributary monitoring program that provides a continuous record of nutrient and sediment loadings covering more than thirty years. Two of its principle sites are the Maumee River at Waterville and the Sandusky River at Ballville.⁷² In 2009, a new water quality station was being installed on the Portage River in Woodville.

Sediment

Sediment is a pollutant in its own right. Ecologically it is important because phosphorus attaches to and is carried with sediment. Generally speaking, actions that reduce the amount of sediment going into the lake will reduce the amount of phosphorus. When sediment settles out, it covers the bottom of streams, bays, and the lake. Doing so, it covers fish feeding and spawning areas.

Accumulating sediment ultimately makes Maumee Bay and some nearshore areas inaccessible. The Toledo shipping channel connects the Maumee River with the Western Basin of Lake Erie. It is dredged some 20 feet below the floor of the Maumee River and Maumee Bay for a distance of 22 miles. Without annual dredging, which averages about 850,000 cubic yards per year,⁷³ the Port of Toledo cannot operate. In 2009, the estimated annual dredging needed to maintain the harbor channel was set at 1,2500,000 cf. Recreational access is also affected by sediment accumulation. The Ottawa and Toussaint Rivers have needed dredging in recent years, as have some marinas. Access to marinas is also strongly influenced by the fluctuating lake levels.

72 *The Ohio Tributary Monitoring Program: 2004 Annual Report. Prepared for the Ohio Department of Natural Resources, Division of Soil and Water Conservation.* Loftus, T. and WQL Staff. 2004.
<http://www2.heidelberg.edu/wql/OTMPreportJuly04.pdf>

73 *Finding of No Significant Impact and Environmental Assessment: Operations and Maintenance Dredging and Placement of Dredged Material, Toledo Harbor, Lucas County Ohio.* US Army Corps of Engineers, Buffalo District, April 2009
 pp 3-4

The biggest environmental issue with sediment is what to do with the material dredged from the Toledo shipping channel?

Since the mid 1980s the dredged material disposal has been split between a Confined Disposal Facility (CDF) and open-lake disposal. Sediments contaminated by chemicals or metals are placed in the CDF. Uncontaminated sediments (which are still a pollutant) have been confined or dumped out in the lake, depending on CDF capacity. Here are the issues and trade-offs:

- CDFs are expensive to build. When a CDF is full, it is necessary to expand it or build another one.
- CDFs cover lake bottom, which is habitat for fish and other aquatic organisms.
- A new or expanded CDF can interfere with access and enjoyment of the lake by lakefront property owners.
- Placing dredged materials removes the sediment and any chemicals they contain from the ecosystem. Confining uncontaminated sediments benefits water quality by taking sediment and phosphorus out of the system.
- Open lake disposal of dredged materials may promote eutrophication by bringing sediment and phosphorus back into contact with the lake water.
- Dredged materials dumped out in the lake may be washed back into the bay by storms. By not removing sediments from the lake, we could be dredging the same sediments year after year. Sediment currents in Maumee Bay are not well understood, and are influenced by the seiche, the shallowness of the bay, and strong flows from the Maumee and Detroit Rivers. A recent study commissioned by the Toledo-Lucas County Port Authority has greatly contributed to our understanding of sediments in Maumee Bay.⁷⁴
- Dredging is necessary for the Port of Toledo to operate. It is one of the largest ports on the Great Lakes, and it is economically very important to the region.

Bacteria

Fecal bacteria are indicative of a variety of waterborne disease organisms, including typhoid fever, cholera, dysentery, infectious hepatitis, and numerous others.⁷⁵ There were outbreaks of cholera in northwest Ohio before public sewerage systems came into use.⁷⁶ In terms of public health, fecal bacteria are the most critical pollutant. Waterborne disease can lead to sickness and death within days. Major outbreaks of these diseases are a thing of the past — a tribute to our public health and wastewater treatment systems.

The sources of fecal bacteria are birds, mammals, and humans. Sewage in water is detected by testing for “indicator” bacteria. One indicator group is called fecal coliform. These bacteria are present in sewage and contaminated water in far greater numbers than pathogens. As such, they are easier to detect, and demonstrate the presence of fecal matter. In recent years many regulatory agencies have begun using a test for a specific bacterium, *Escherichia coli* (*E. coli*).

In streams, the presence of fecal coliform has documented the need for sewerage facilities to eliminate septic systems, package plants, sewer overflows, and to mandate improved sewage treatment. Despite these

⁷⁴ *The Results of a Sediment Trend Analysis in Maumee Bay, Lake Erie*, GeoSea Consulting, 2003

⁷⁵ *Water and Wastewater Engineering, Volume 2*, Fair, Geyer, and Okun, John Wiley & Sons, 1958; pp 19-4 through 19-9

⁷⁶ One such outbreak is discussed in *An Historical Gazetteer of Wood County Ohio*, Lyle Rexford Fletcher, Emeritus

Professor of Geography, Bowling Green State University, 1988, page 116

improvements, fecal bacteria counts often exceed standards at public beaches. This problem is not unique to our area; in fact, it is very common on beaches nationwide.

There are many possible sources of fecal bacteria, as noted above. Understanding what bacteria sources contaminate a given beach is complicated by the question of survival. Normally fecal bacteria do not survive long in a waterway. Studies of Maumee Bay and Wolf Creek in eastern Lucas County indicate *E. coli* accumulate in stream sediment, where they may survive for extended periods and be stirred up again by a later storm.⁷⁷ Further research is needed for a better understanding of the sources of fecal contamination, survival, and travel in Maumee Bay and the Lake Erie near the shore.

Legal Basis of the *Areawide Water Quality Management Plan*

The final issue to cover in this chapter is background for the “208” *Areawide Water Quality Management Plan* itself. This includes the plan’s legal basis, requirements, and the process by which it is updated or amended.

The Federal Water Pollution Control Act Amendments of 1972 called upon Areawide agencies such as TMACOG to develop Areawide Water Quality Management Plans. The Areawide Plan described under §208 of the Act, is certified by the Governor of State as part of the State’s Water Quality Management Plan. Many agencies -- federal, state, areawide, and local - are given specific responsibilities to implement specific provisions of the Act.

Water Quality Management Plan Requirements

The Clean Water Act sets Water Quality Management Plan (WQMP) requirements for both states and Areawide Agencies. Section 208 describes the requirements for Areawide plans, and §303 describes state requirements. The state’s WQMP incorporates all the Areawide plans. After amendments to an Areawide plan have been adopted by TMACOG, they go onto the State agency for certification and inclusion in the State plan. The TMACOG *Areawide Water Quality Management Plan* was originally certified by Michigan Governor William G. Millken on January 9, 1980; and by Ohio Governor James A. Rhodes on May 4, 1981.

Current US EPA regulations require fundamentally the same elements, but are less rigid about which are prepared by the State and which by the Areawide. The regulation, 40 CFR 130.6: Water Quality Management Plans, is summarized below:

- A) Water Quality Management Plans. WQMPs consist of initial plans and certified updates. Continuing water quality planning shall be based upon WQMPs and water quality problems identified in the latest 305(b) reports. State water quality planning should focus annually on priority issues and geographic areas and on the development of water quality controls leading to implementation measures.
- B) Use of WQMPs. WQMPs are used to direct implementation. WQMPs draw upon the water quality assessments to identify priority point and nonpoint water quality problems, consider alternative solutions and recommend control measures, including the financial and institutional measures necessary for implementing recommended solutions. State annual work programs shall be based upon the priority issues identified in the State WQMP.
- C) WQMP elements. The following plan elements shall be included in the WQMP. Some are part of Areawide Plans, and others are covered instead by the Statewide Plan.

- i) Total maximum daily loads (State WQMP).
 - ii) Effluent limitations (State WQMP).
 - iii) Municipal and industrial waste treatment. Identification of anticipated municipal and industrial waste treatment works, including combined sewer overflows (Areawide WQMP).
 - iv) Nonpoint source management and control (Areawide WQMP).
 - v) Management agencies. Identification of agencies necessary to carry out the plan and provision for adequate authority for intergovernmental cooperation. Management agencies must demonstrate the legal, institutional, managerial and financial capability and specific activities necessary to carry out their responsibilities (Areawide WQMP).
 - vi) Implementation measures. Identification of implementation measures necessary to carry out the plan (Areawide WQMP).
 - vii) Dredge or fill program. Identification and development of programs for the control of dredge or fill material (State WQMP).
 - viii) Basin plans. Identification of any relationship to applicable basin plans developed under section 209 of the Act (State WQMP).
 - ix) Ground water. Identification and development of programs for control of groundwater pollution (State WQMP).
- D) Update and certification. State and/or Areawide agency WQM plans shall be updated as needed to reflect changing water quality conditions, the results of implementation actions, new requirements or to remove conditions in prior conditional or partial plan approvals.
- E) Consistency. Construction grant and permit decisions must be made in accordance with certified WQM plans as described in the code of federal regulations §§130.12(a) and 130.12(b). In addition, Ohio law provides that permit decisions must be made in accordance with adopted WQM plans. The Ohio Revised Code specifies this requirement:

6111.03(j)(2) An application for a permit or renewal thereof shall be denied if any of the following applies:

... (b) The director determines that the proposed discharge or source would conflict with an areawide waste treatment management plan adopted in accordance with section 208 of the Federal Water Pollution Control Act;...

Watershed Action Plans

Many water quality projects are implemented through river basin or watershed councils. Doing so allows project goals to focus on protecting and improving water quality without the limits of jurisdictional boundaries. This Plan recognizes and supports the goals of these watershed councils. Watershed Action Plans that are incorporated by reference as part of this Plan are listed in Chapter 2. The watershed councils and their Watershed Action Plans are:

1. Maumee River Remedial Action Plan (RAP) / Partners for Clean Streams: Maumee AOC Stage 2 Watershed Restoration Plan⁷⁸
2. Duck and Otter Creek Partnership⁷⁹
3. Portage River Basin Council⁸⁰

⁷⁸ <http://www.partnersforcleanstreams.org/stage2.html>

⁷⁹ http://www.dopartnership.org/Home_Page.html

⁸⁰ <http://www.tmacog.org/prbc.htm>

Plan Amendments

Maintaining this Plan is necessary to keep it relevant to local and regional needs. For two examples:

- Wastewater treatment facility needs (Chapter 4) change as communities replace or upgrade their systems, or provide service to new areas.
- Critical Sewage Areas (Chapter 5) change, as designated by local Health Districts, when stream or septic system testing indicates new areas, or when a sewer extension eliminates problems.

The TMACOG Environmental Council is the forum for review of *Areawide Water Quality Management Plan* amendments. Amendment requests may be made by members of the Environmental Council or Designated Management Agencies (DMAs). The Environmental Council makes recommendations on Plan amendments to the TMACOG Board of Trustees. The Board adopts the Plan. When all or part of the *Areawide Water Quality Management Plan* is amended by the TMACOG Board of Trustees, the new version supersedes all previous versions of that part of the Plan. After adoption by the Board of Trustees, the Plan is submitted to the Governors of Ohio and Michigan for Certification. See Chapter 3 for a description of the amendment process and a listing of Designated Management Agencies.

81 <http://www.sanduskyriver.org/>
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