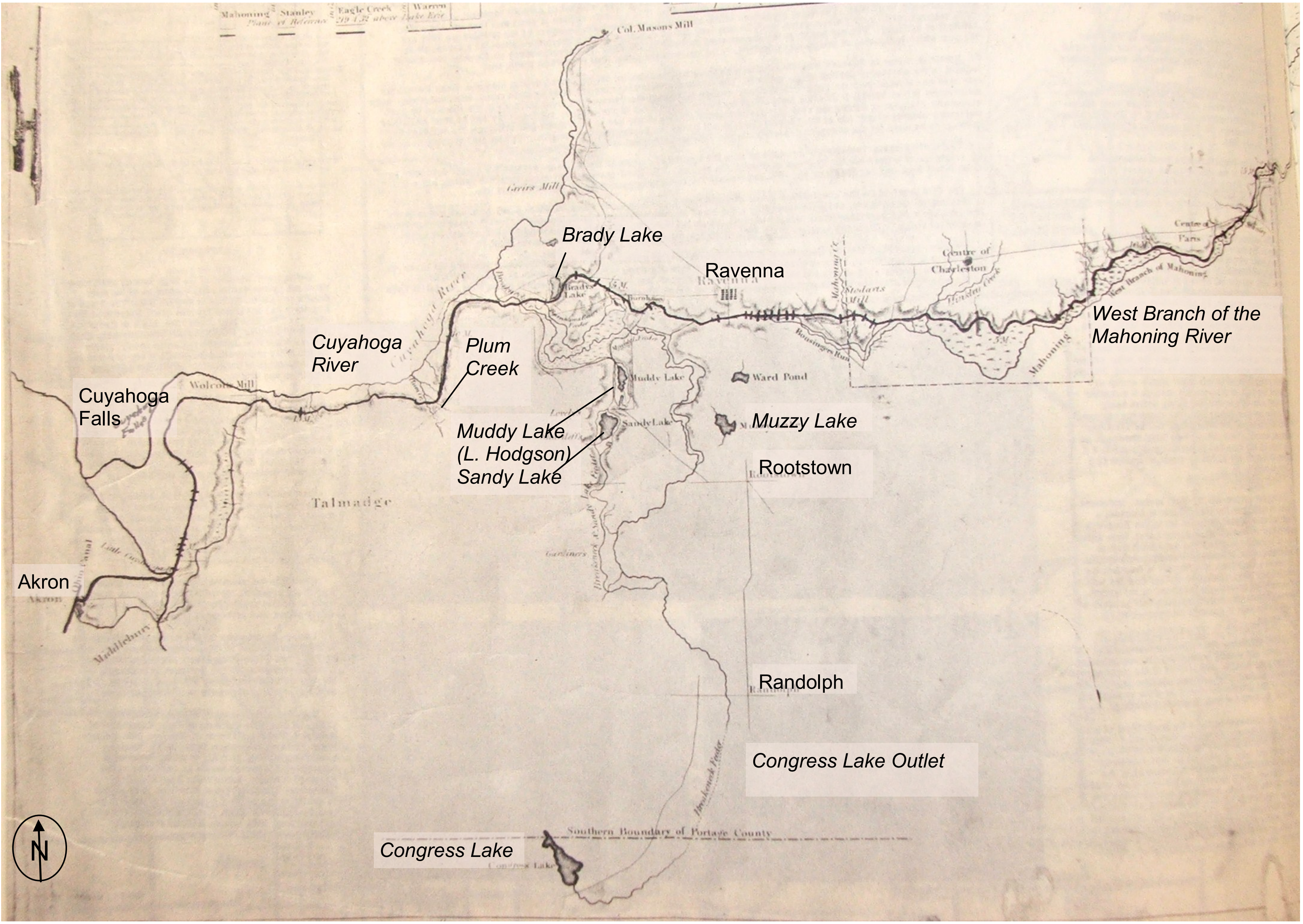


Figure 4b-1 1840s Map of the Pennsylvania and Ohio Canal—Pennsylvania border to Akron

Source: Map and Profiles of the Pennsylvania and Ohio Canal, 1840s (from Portage County Centennial map collection) was no longer in use for freight, but mill owners downstream retained water rights for their mills by taking one round trip up the canals per year. In the 1870s, local residents, tired of the stagnant water along the P&O Canal, breached the canal walls in several locations.

Over the years, additional canals were sold, dynamited after the 1913 flood, or otherwise destroyed. However, remnants of canal channels ("prisms") and locks may be found along the route of the former canals, including:

- Kent - canal remnants are found at the historic dam, upstream at "Brady's Leap," and at the site of an aqueduct over Plum Creek;
- Munroe Falls – canal prism is visible south of the river near Route 91. Brust Park has a historical marker.
- Cuyahoga Falls – even though there is no marker, the canal prism remains at the railroad crossing at Water Works Park. The "Chuckery Race" stone walls, an attempt to bring canal water down the Cuyahoga River Gorge, are still evident in Gorge in Cuyahoga Falls.
- Outside this watershed, portions of the canal, individual locks, and canalside buildings are still intact in Trumbull County, Stark County, Akron and the Cuyahoga Valley National Park.
- Throughout the watershed and beyond it, former canal towpaths are being used for an extensive network of extremely popular bike-hike trails. The Cuyahoga Valley National Park and the Ohio-Erie Canalway are two major efforts in the vicinity of the Middle Cuyahoga River watershed to join recreational opportunities, economic development (tourism), and the canal histories.

The P&O Canal resulted in some important alterations to the hydrology of the subwatershed, some of which still remain.

- The Congress Lake Outlet and Feeder Canal were dug to provide water for the P&O Canal. After the demise of the canals, these were used to supply water to a worsted wool mill in Ravenna, and are currently used to provide an additional source of water to the Lake Hodgson, the City of Ravenna water supply.
- The Feeder Canal entered Breakneck Creek at a slackwater (dam pool) and then re-entered the creek near Hommon Rd., which is currently the ditch providing drainage for the Ravenna Waste Water Treatment Plant.
- Sandy Lake, Lake Hodgson, Muzzy Lake, Brady Lake, and the Twin Lakes were all originally kettle lakes, but dams were added to help provide water for the feeder canal, and these became "surge" sources. These would collect water during spring snow melt and storms, and the water would later be fed into the canals. Many of these lakes still have dams.

Prehistoric Settlements and Artifacts

Prior to the settlers' arrival, various prehistoric peoples inhabited the region, often living along the rivers. By about 2,000 years ago, middle Woodland period peoples began constructing villages and enclosures along high bluffs overlooking the rivers. During about 1000 to 800 years ago, the populations increased, and permanent villages were established on hilltops and bluffs overlooking the major river valleys. These villages, apparently built for defense, housed dozens of families from late spring to early fall, sometimes year-round. The group disappeared from northeast Ohio about 350 years ago, so The abundant and distinctive remains of this latest prehistoric society are known as Whittlesey cultural tradition, named after the archaeologist who identified the culture from artifacts. During the 1700s, refugee tribes located in Ohio, but they were subsequently displaced by policies favoring settlers and relocating native peoples. Prehistoric mounds have been found in the region. One is preserved in the Towner's Woods Park in Portage County. Other sites identified as high probability of having archaeological remains include the high bluffs overlooking tributaries and rivers. As pointed out in the Portage County Watershed Plan, preservation of these areas may coincide with preservation goals for watershed functions.

http://www.cmnh.org/site/ResearchandCollections/Archaeology/Research/GeneralAudienceNontechnicall/HistoryNEOhio.aspx
Portage County Watershed Plan. Ravenna, OH.
http://co.portage.oh.us/watershedmaps102006/2.1%20Existing_Demographic.pdf

Amusement Parks

During the late 1800s and early 1900s, Ohio experienced a boom in amusement parks. Three were formerly located within the watershed:

- High Bridge Glens Park was built in 1882 in downtown Cuyahoga Falls along the Gorge. The amusement park, easily accessible by rail, contained one of the earliest roller coasters, a dining hall and dance hall pavilion, trails down in the Gorge to Mirror Lake, Fern Cave, a suspension bridge over the river, and toy houses for children. Construction of the Northern Ohio Traction and Light Company dam (predecessor to Ohio Edison) in 1912 created a dam pool that backed up into the park, obscuring the scenery for which visitors came, and the park closed. Industrial development during the early 1900s used the site. However, the now-vacant buildings have been removed.

  The City of Cuyahoga Falls has recently opened a boardwalk, reconstructed a bridge over the gorge, and placed a historical marker at the site of the former High Bridge Glens Park. Sources: Ohio Historical Marker; Cuyahoga Falls Historical Society, http://www.cuyahogafallshistory.com/parks_high_bridge_glens.htm

- Silver Lake Amusement Park, Silver Lake. This spring-fed lake, formerly Wetmore Pond, was developed by Ralph Hugh Lodge for an amusement park in 1875. The regional resort had boating, swimming, a dance pavilion, rail access, an aquarium, and an air field. The Lodge family raised black bears, a novelty. The Lodges sold the land was sold for residential development in 1918, as rail travel was limited during World War I, and the residents have sole rights to the lake. *Source: Summit County Historical Society http://summithistory.org/Community/museum_silverlake.htm*

- Brady Lake Electric Park was erected by A.G. Kent in 1891. It was accessible by rail and contained a dance hall pavilion, roller coaster, row boats, a steam boat and pony track. Source: The Art Armory. *http://www.artarmory.com/kent/brady.html*

Other areas in the Middle Cuyahoga River Watershed boast items of local and regional historical interest:

- In the early 1800s, the legendary Indian scout, Captain James Brady, was being held captive by local Indians. He escaped and fled, reportedly leaping a distance of 22 feet across the chasm of the raging Cuyahoga River in Kent. This site is known as Brady's Leap and is part of the river-side series of parks in Kent, marked with a plaque on a granite boulder. The bedrock channel has since widened, but the daring of his leap is still apparent. He then continued his flight and hid under a log a few miles away in what is now known as Brady Lake.

- Mary Campbell Cave in the scenic Gorge MetroPark is the site where a settler's daughter was held after capture by local tribes.

- Accounts of early life in Brimfield included mucking out the extensive swamps and placing a dam on Plum Creek for water power.

- Governor William McKinley provided assistance to form the public Canton Outing Club in 1894, the precursor to the Congress Lake Club, which became privately owned in 1899. source: https://congresslakeclub.memberstatements.com/tour/tours.cfm?tourid=52744

Recreational Resources

- In addition to the parks noted previously in Section 4a-iv.2, several major recreational efforts are underway that and promote the river as a center of recreational activity and major attraction for visitors.

- The Cuyahoga Valley National Park, one of the most heavily visited national parks, is located a short distance downstream of the Cascade Valley MetroPark, the western-most extent of the Middle Cuyahoga River. The National Park shares much of the same historical interest as the watershed, focusing on the Ohio and Erie Canal and the Cuyahoga River. In a program similar to geocaching, the National Park, Ohio and Erie Canalway trail system, and MetroParks, Serving Summit County, have recently begun a "questing" program focused on the Ohio and Erie canalway. Like geocaching, questing involves following clues to reach a set destination. However, questing does not involve the exchange of trinkets and does not require the use of gps systems, but instead, relies on clues focusing on the history or natural history of the quest area. This approach, being used in other regions, offers another activity and attraction focused on the Cuyahoga River.

- Communities and other partners along the entire river are seeking to establish a water trail for paddling. This concerted effort involves developing and publishing a map that identifies resources, paddling conditions, items of local interest, portages, pull-out opportunities and obstacles. Various partners along the river are focusing on developing each segment. The Middle Cuyahoga River would include the Heritage Section from Kent to Cuyahoga Falls, and a portion of the Expert Section in the Gorge and downstream. With the establishment of the canoe livery at Kent and accessible, high quality waters, the water trail partners perceive the Heritage Trail as the furthest along in development as a water trail segment.

- River Day is observed in many communities along the River during May, including Kent, Munroe Falls, and Cuyahoga Falls. Portage Park District sponsors Breakneck Creek Day on the same day as River Day each year.

4c – Previous and Complimentary Efforts

Communities and organizations within the Middle Cuyahoga watershed have been involved in watershed planning and management efforts to some degree for over 30 years. The following are some of the major studies and watershed management efforts within the watershed. Often, various watershed planning studies agree on the need and general techniques for:

- Protecting and restoring riparian corridors and wetlands
- Regional approaches to water resource management
- Restoring natural flow in waterways, especially the Cuyahoga River
- Reducing sediment, nutrients, pathogens, and non-point source pollutants from agricultural land, construction sites, failing or inadequate HSTS,
- Protecting surface and groundwater supplies,
- Controlling combined sewer overflows
- Public outreach and stewardship.

This Watershed Action Plan draws upon information developed for earlier studies and seeks to be consistent and compatible with similar and related efforts. As possible, the partners will collaborate with other organizations to achieve shared goals and promote the goals expressed in this plan.

Reports and Plans

Previous management studies are numerous and include the following:

NEFCO, as the Areawide Planning Agency for Summit, Portage, Stark, and Wayne Counties, has compiled the region's Section 208 Water Quality Management since the inception of the program. The Section 208 plan specifies areas to be served by sewers but also establishes a number of other goals related to watershed management and water quality. Included in the most recent version of the Section 208 plan are measures such as reduction of non-point source pollution, restoration of urban streams, regionally important waters, reduction of non-point source pollution. NEFCO has also conducted numerous watershed-related studies in the area, including:

- 1989-90, Analysis of Nonpoint Source Pollution within the Lake Hodgson Watershed, quantifying sediment erosion in the Lake Hodgson watershed and making recommendations that were later incorporated in the Source Water Protection Plan, including monitoring of water quality in the Feeder Canal and use of aeration devices at depth to reduce recycling of nutrients.

- 2004, Comprehensive Watershed Management Plan, Phase I, Middle Cuyahoga River Watershed. NEFCO convened a Middle Cuyahoga River task force of Middle Cuyahoga River partners to develop a watershed plan. The collaborative effort resulted in an inventory with goals and objectives, but it was interrupted by lawsuits involving the City of Akron and downstream communities concerning releases of water from the Akron public water supply at Lake Rockwell.

- Breakneck Creek Watershed Management Plan Inventory, 2004

Additional water quality management studies pertaining to the watershed include:

- Portage County Regional Planning Commission, in partnership with NEFCO, Portage Park District, Portage Soil and Water Conservation District, and several other organizations, developed the Portage County Watershed Plan, highlighting key resources to protect and establishing the basis for corridor protection.

- Survey of Northeast Ohio Home Sewage Disposal Systems and Semi-Public Sewage Disposal Systems, NOACA Septic System Study, 2001. This study identified factors correlated with high rates of septic system failure.

Water Quality Improvement Projects

- The Cuyahoga River has been the subject of three Total Maximum Daily Load analyses, which are described further in Section 5a-1. The Kent and Munroe Falls dams were altered or removed to restore flow in response to the Middle Cuyahoga River TMDL, resulting in water quality improvements.

- The City of Kent removed a small low-head dam from Plum Creek and restored the channel and floodplain. The City of Cuyahoga Falls already removed a small low-head dam on Kelsey Creek and is in the process of restoring floodplain access, channel form, and riparian corridor along the creek in Kennedy Park.

- The City of Cuyahoga Falls will be removing two low-head dams from the Cuyahoga River in 2013.

- The City of Stow recently stabilized a severely eroding portion of Walnut Creek.

- Implementation of NPDES Stormwater Permits. In 2003, new regulations went into effect requiring small Municipal Separate Storm Sewer System providers to develop and implement stormwater best management practices in order to receive General Permits for stormwater discharge. The General Permit entails requirements for six minimum control measures, including illicit discharge elimination, good housekeeping practices, stormwater management programs, and public information and public education programs. Both Summit and Portage Counties have developed collaborative County-wide programs that include public information and public education groups comprised of municipal, township, and county officials. Portage County has recently begun implementing its stormwater management program.

- Potter Creek Restoration Project - NEFCO obtained an implementation grant to improve an agricultural headwater stream in Portage County. Collaborators included the City of Ravenna, Portage Soil and Water Conservation District, Cuyahoga River RAP, and Portage Parks District. The project was designed but not constructed. Over 20 acres of diverse wetland habitat were protected through easement purchase.

- Wastewater treatment plants at Franklin Mills and Ravenna were upgraded to improve water quality between 2000 and 2007.

- Portage and Summit Counties have adopted programs to reduce septic system failure that focus on design of new systems and maintenance or improvement of pre-existing ones.

- Summit County, Kent, Ravenna, Tallmadge, and Munroe Falls have adopted riparian setback requirements for development.

4c-ii Current Water Quality Efforts

- The City of Akron is currently implementing the early phases of a Long Term Control Plan under agreement with the US EPA to control combined sewer overflows, which affect the lower portion of the Middle Cuyahoga River.

- Summit County is undertaking a regional stormwater management study. The focus of this is on managing water quantity, but it is hoped that a regional approach to controlling water quantity can identify needs and opportunities for water quality improvement.

- Portage County has recently adopted a stormwater utility countywide, to provide a funding source for managing stormwater across the county.

- Portage County Regional Planning Commission has installed a stormwater infiltration trench in its parking lot.

- Several cities in the watershed have installed rain gardens as demonstration projects.

- Summit County is conducting a brownfields inventory and brownfields remediation pilot project. Portage County is seeking funding for a brownfields inventory.

- The Ohio Edison dam is being evaluated for removal.

- Cuyahoga Falls will be removing two low-head dams on the Cuyahoga River in 2013. The City is pursuing funding to reconnect large portions of Kelsey Creek to its floodplain, in the Brookledge Golf Course. The City is working with a school at the edge of Kennedy Park to develop a city arboretum along Kelsey Creek, which will provide hands-on projects for the high school students, increase awareness, and improve the riparian corridor.

- MetroParks, Serving Summit County, will be restoring stream morphology in the newly acquired portion of Munroe Falls MetroPark. Portage MetroParks is conducting a stream restoration and has recently acquired 45 acres of riparian corridor/wetland near Breakneck Creek.

Individually, partners have taken the initiative to conduct restoration and other water quality efforts. In implementing this plan, the partners will build on previous successes and collaborations.

4d – Physical Attributes of Streams and Floodplain Areas

<u>Organization of Sections 4d-4e</u>

Section 4d through 4e discuss physical characteristics of the stream corridors, alterations, threats to water quality, and the resulting water quality indicators. While the previous sections have focused on the characteristics of the watershed, the next three sections focus on what aspects are providing benefit, which should be protected, which should be restored or improved. These will provide much of the basis for determining what the watershed partners wish to accomplish toward protecting and improving the river, tributaries, and watershed.

This background section discusses how the landscape elements of the stream corridor interact to affect water quality, the functioning of streams and rivers, their stability and resilience, and hazards such as flooding problems, excessive erosion, and harmful algae blooms. Altering the landscape can affect water quality and the functioning of the stream system. The goal of the watershed partners is to protect the beneficial stream systems and elements and restore or improve the elements that have been degraded. While restoring full water quality attainment and all the stream functions may be an ideal, in some cases it may be feasible only to restore some of the functions lost in an altered setting, thus improving the system.

The outline contained in Appendix 8 lists factors to consider in assessing stream channel condition, many of which are assigned their own section number in Sections 4d-4e and some of which are repetitive. However this document combines similar topics into fewer groups:

Section 4d

Stream Systems and Water Quality Background

1. Pre-Settlement Conditions
2. Channel and floodplain condition, including livestock access, eroding banks, floodplain connectivity, entrenched channels, intact or altered
3. Forested riparian corridor
4. Permanent protection
5. Altered Stream Network
6. Dams and Petition Ditches
7. Status and trends
8. Expected development
9. Expected road, highway, and bridge construction

Section 4e

1. Designated Use, Attainment, Causes, Sources
    a. Water bodies
    b. Lakes
    c. Wetlands
    d. Groundwater
2. Point Sources
    a. Permitted Discharges, effluent volume
    b. Spills
3. Non-point Sources
    a. Home Sewage Treatment Systems
    b. New Homes
    c. Animal Feeding Operations
    d. Highly Erodible Land, Potential Soil Loss
4. Status and Trends

Stream Systems and Water Quality: Background

Stream Systems and Water Quality: Background

Physical and Chemical Factors Influencing Water Quality and Biological Indicators

The Ohio EPA enforces Ohio's federally mandated water quality standards, which are expressed in terms of beneficial uses. Ohio EPA focuses considerable effort on attainment of aquatic life use standards, because the biological communities reflect and are good indicators of the physical and chemical conditions of stream systems. However, in framing the discussion of stream systems, it is useful to understand the factors that contribute to biological communities and thus, water quality attainment status.

Figures 4d-1 and 4d-2 illustrate that the biological communities are a result of tiered influences related to the physical environment, each level being affected by others. Even though it is not shown in the illustration, it is important to note that chemical parameters are also important at the various levels.

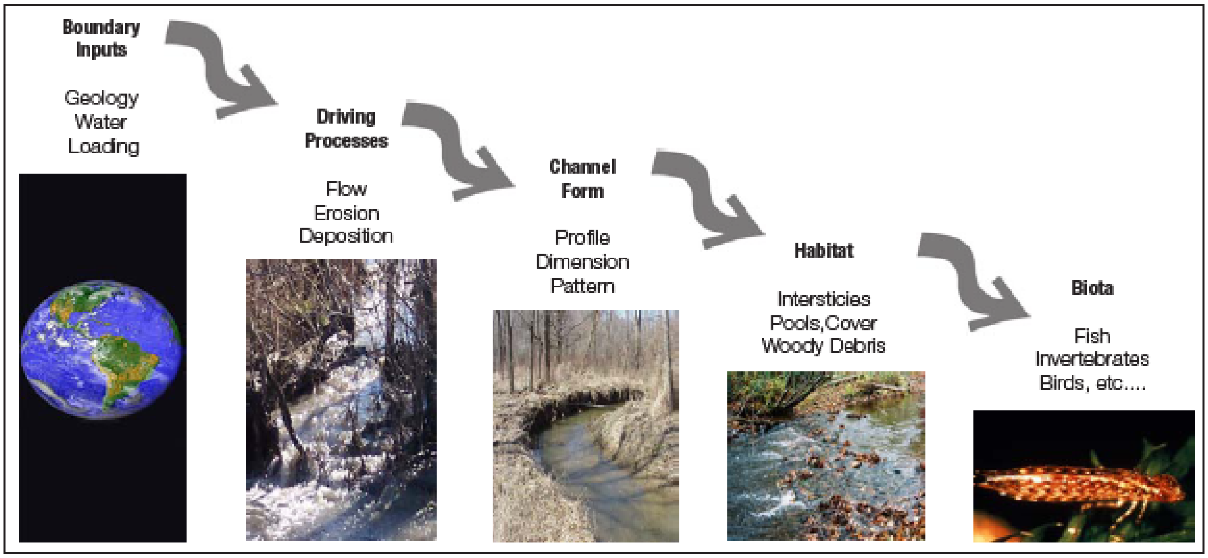


Figure 1 Relationship of the stream variables responsible for stream integrity

Figure 4d-1 Relationship of the stream variables responsible for stream integrity. *Source: Ohio Rainwater and Development Manual, App. 7, Planning for Streams, Fig. 1. Ohio DNR, 2006.*

Biological communities depend on

- Physical/chemical parameters of the water, including nutrients such as nitrogen and phosphorous, sediment/turbidity, light penetration, temperature, and oxygen;
- Habitat, including variable flow and depth, substrate with surfaces to adhere to (e.g., gravel versus silt), cover, vegetation, condition of the banks and riparian zone (transition between stream and upland); and
- The physical, chemical, and habitat characteristics depend largely on stream form, including the accessible floodplains, wetlands, and riparian zone; bank slope, meanders, and bank vegetation. These characteristics are also affected by biological communities, and the amounts of sediment, water, and chemicals entering the system.

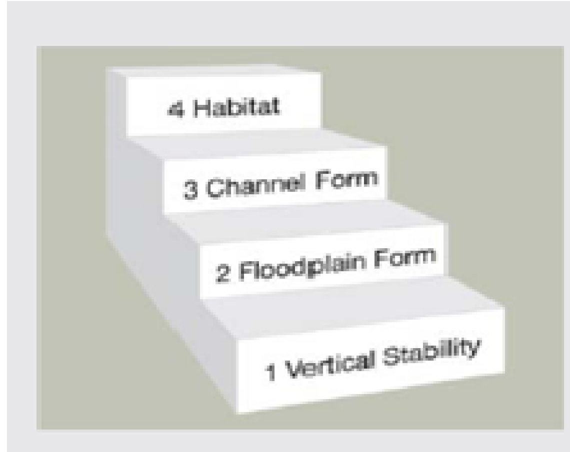


Figure 4d-2 Physical characteristics provide the basis for habitat and biological communities *Source: Ohio Rainwater and Development Manual, App. 7, Planning for Streams, Fig. 1. Ohio DNR, 2006.*

- The stream form depends on the vertical stability of the stream, whether the stream is in balance with the flow, slope, and sediment load or is, instead, eroding vertically downward or silting in. Vertically stable streams meander, eroding outside bends and depositing at inside curves (point bars). Over time, the meanders shift, but the stream can maintain a consistent plan, dimension, and profile. Key to maintaining stream form is floodplain access.
- Vertical stability depends on the amount of water and sediment coming into the system, the stream slope, sinuosity, and floodplain access. When the system is out of balance due to a change in the volume of water in the channel (e.g., through loss of floodplain access or increased runoff), a change in slope (e.g., through channel straightening), or change in sediment input, the stream adjusts by eroding the channel wider and deeper or silting in. Both types of adjustment damage the stream form, impair habitat and water quality attainment, and may increase risks of flooding damage or unstable banks.
- The amount of inputs also affects the levels of contaminants, nutrients, oxygen, and nuisance species. Many of the inputs of water and contaminants can be reduced or treated if the elements of the stream channel and stream form are intact.

In assessing the health and functioning of a stream system, factors such as stream form and inputs are as important as biological and chemical attributes, providing the basis for the conditions within the stream system.

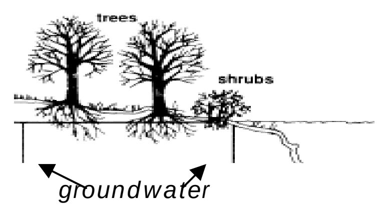
Stream Corridors - Landscape Functions

The physical characteristics of the stream channel and corridor play a major role in the health of the stream system and the way it functions, affecting many of the characteristics noted above. The landscape elements of an intact stream system perform functions that are not only essential for healthy biological communities but also reduce flooding and erosion problems, bank instability, and nuisances such as harmful algal blooms and levels of certain toxins in drinking and recreational waters. An intact stream corridor landscape is one of the most effective tools to provide flood reduction and storage and water treatment, minimizing impacts to the stream system (and downstream properties), and maintaining a healthy stream system.

Important landscape elements of the stream corridor are shown in Figures 4d-3 and 4d-4, and include:

- Vegetated upland buffer – undisturbed, vegetated land above the low-lying stream corridor – absorbs and filters precipitation and runoff and contributes to habitat.

- Accessible floodplain, where water can spill out of the channel. This reduces the load on the stream channel and the erosive force of the water, is crucial to stream channel stability, and allows sediment to settle out.



- The riparian zone is the transition between the stream and upland, where the groundwater is close to the surface and interacts with the stream. Water-loving and water tolerant plants “get their feet wet” with their roots in the groundwater. An intact, vegetated riparian zone provides nutrient uptake, filtering of runoff, and streambank stability.

- Wetlands in the low-lying stream corridor area store floodwater, are important absorption, storage, and adsorption of contaminants. During dry periods, wet base flow to streams.

- Stream form, with meanders or step-pool sequences, variable flow, and often banks. These features are present in intact stream systems, although they m stream slope. They provide habitat (pools and gravel-lined riffles), increase c water, allow sediment to be scoured from the active channel and deposited on bars and floodplains, and are important to maintaining vertical channel stability.

- Riparian vegetation – trees, shrubs, and even tall grasses help absorb precipitation and runoff, take up and absorb nutrients, provide bank stability with their root systems, and help maintain lower water temperatures, important for certain organisms and maintaining dissolved oxygen levels.

Collectively, these elements are important for maintaining vertical stability, stream form, floodplain access, flood storage and attenuation, pollutant uptake, and habitat. The assessments of stream corridor conditions in this Watershed Action Plan consider the presence and quality of these features at the watershed scale, and where the features – or their functions – should be protected, improved, or restored.

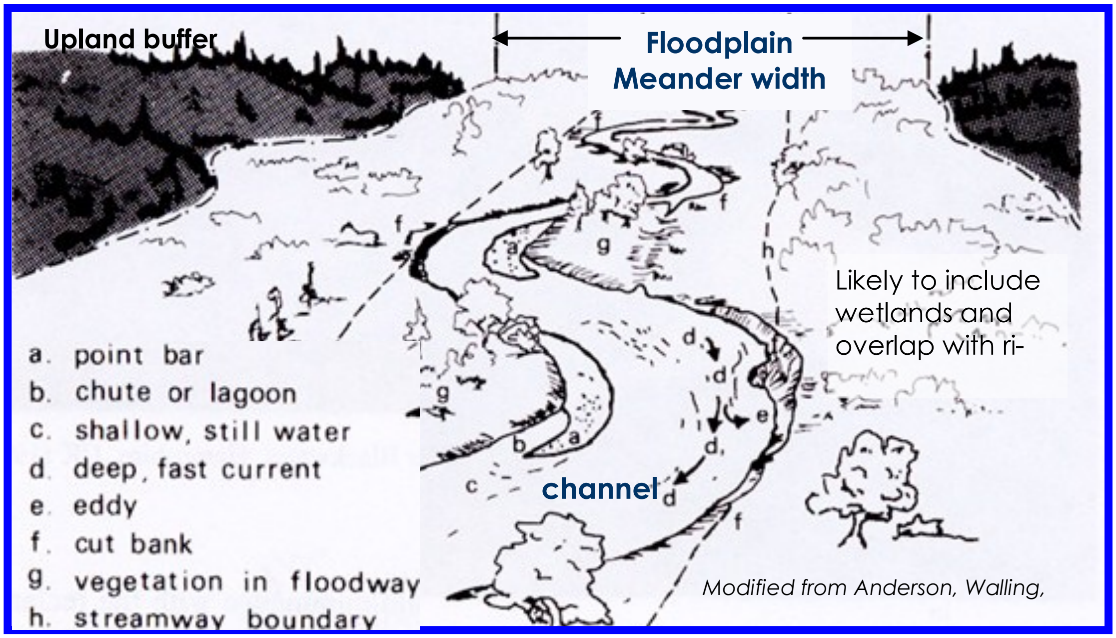


Figure 4d-3. Features of an Intact Riparian Corridor

Riparian zones, wetlands, and floodplains often coincide in the low, wet areas along the streams in the Middle Cuyahoga River watershed.

Upland slope – absorbs water – during a day-long storm, only a minimal amount of water trickled off the slope into the stream below. Wooded buffers are even more effective at absorbing water, preventing erosion, and taking up nutrients.

Floodplain at work storing water

Figure 4d-4. Landscape Elements Provide Watershed Benefits, Middle Cuyahoga River Watershed

Figure 4d-5 Vertical Stability of Streams

Vertically stable streams (left) have accessible floodplains and riparian zones, and will not erode or silt in over time. (Source: R. Keitz Ohio DNR Oster-Zimber Ditch Presentation n.d.) In contrast, the unstable channels at the right have tall vertical banks. The channel at the top right has uniform, slow flow, with no floodplain access. With no way to clear the sediment out from the channel, it is silting in. The channel at the bottom right s overloaded, has no access to a floodplain, lacks stabilizing vegetation, and is eroding vertically.

4d-1 Pre-Settlement Conditions

Findings:
Pre-Settlement Conditions

In 1966, the Ohio State botanist published *Natural Vegetation of Ohio, at the Time of the Earliest Surveys*, using methods developed in the 1920s to map early surveyors' records of trees. Ohio DNR has since digitized the map into the GIS system.

As shown on Figure 4d-6, the Middle Cuyahoga River watershed was a predominantly mixed oak forest, with mixed mesophytic woods occurring in the eastern portion of the watershed. While the watershed lacked the extensive wetlands of the Black Swamp system in northwest Ohio, there were substantial peatlands along Potter Creek, Fish Creek, and the confluence of the current Brimfield Ditch and Breakneck Creek. The lakes in the watershed are generally kettle lakes, which pre-date the canal alterations. Writings from early settlers describe the clear waters of the Cuyahoga, a ford at Munroe Falls, and extensive swamps in Brimfield. http://www.dnr.state.oh.us/website/ocm_gis/mapviewer_app/default.asp

As discussed in the next several sections, since the settlers first came, the residents of the watershed have been altering the hydrology to harness water power, provide transportation, drain wet areas, change flooding patterns, create dry land for farming and building, dispose of waste, and develop water supplies for industry, drinking, and recreation. Alteration continues as the land is used for agriculture, new housing and commercial developments. As the stream network is altered, the stream corridor functions are often reduced, resulting in increased loading of water and pollutants, streambank instability, and damaging floods.

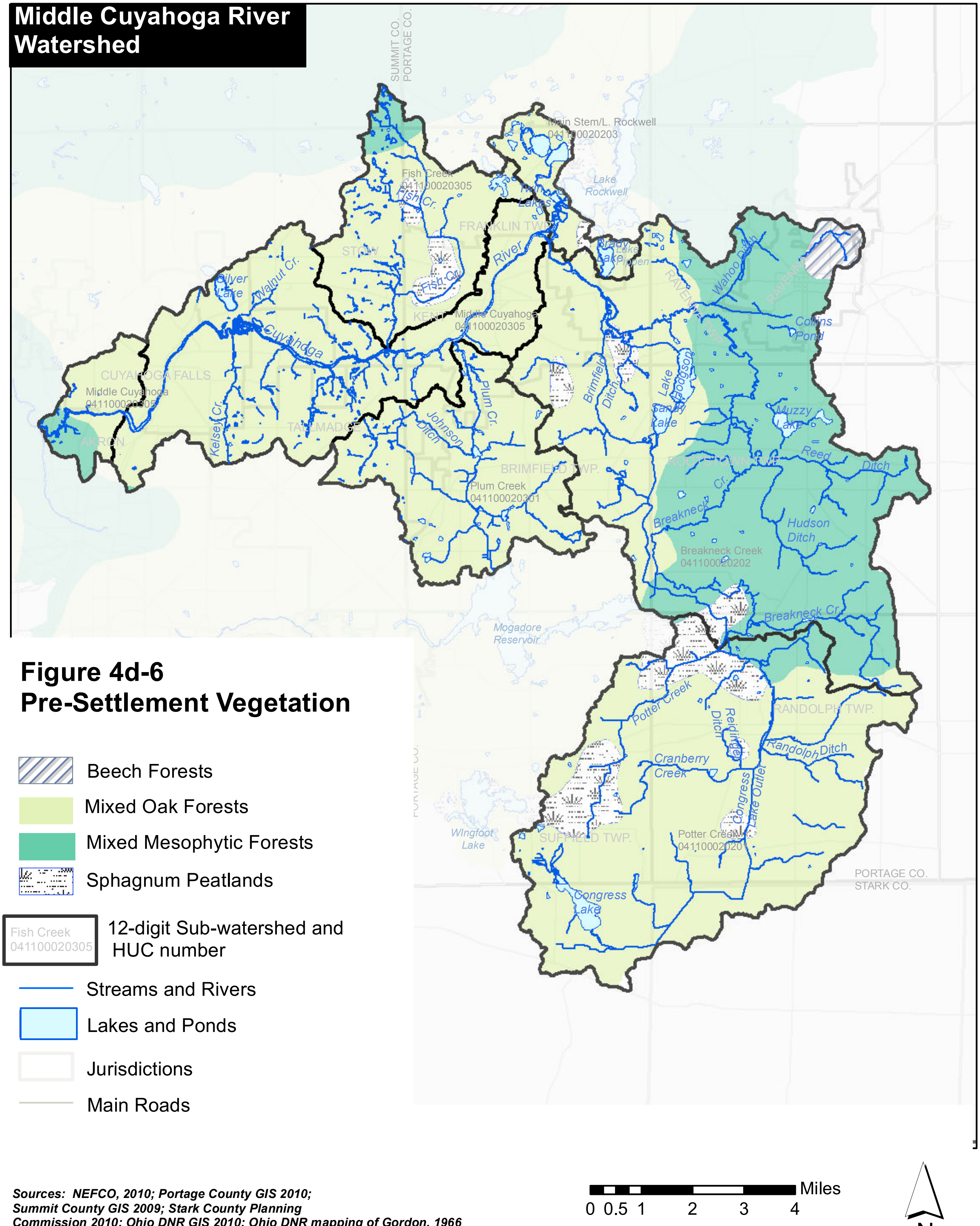


Figure 4d-6
Pre-Settlement Vegetation

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; Ohio DNR mapping of Gordon, 1966

4d-2 Channel and Floodplain Conditions

Mapping

Channel conditions were assessed visually through field visits to stream access points and through interpretation of aerial photographs from 2006. Channels were classified as intact (appearing to have features of an intact riparian corridor), recovering, eroding, eroding with livestock access, channelized, or altered. There is considerable overlap between the categories. Channels mapped as "eroding" may also be incised or incising, or could be expected to become incised soon and also likely has lost floodplain access. The "altered" category as mapped is a broad one and could to conditions ranging from lack of riparian vegetation to completely culverted or hardened. Photographs in Section 4P can be used to further determine characteristics at photograph sites. It should be noted that certain characteristics or features may not be visible from the aerial photographs, and the limited number of field visits did not allow all channels to be observed under ideal viewing conditions. For instance, during summer, dense vegetation makes visibility difficult, and during fall, winter or spring months, high water can mask the shape of the channel or the nature of the vegetation. As with all mapping in this plan, field assessments are necessary to more clearly define conditions at specific sites.

Findings:
Channel Conditions, Middle Cuyahoga River Watershed

Findings: Channel conditions

Figure 4d-7 presents mapped channel conditions, which are summarized in Table 4d-1. Figure 4d-7 also presents photo locations. Photos in Attachment 4P are referenced for example, as 4P xx-###, where xx is the subwatershed designation, and the numbers refer to the photo number in that set.

Outside the impounded dam pools, the Cuyahoga River channel is largely intact (or recovering its forested riparian corridor.) Much of the tributaries and their surrounding landscape have been altered by drainage ditching, agriculture, or development.

In the urbanized portions of the watershed, substantial portions of stream channels and the adjacent landscape have been altered:

- Direct alteration, e.g., through dam construction, by culverting, hardening the channel, or mowing or filling riparian buffer (e.g., 4P MS-340, 345, p. ms5; BC-070, p. b-9, BC-360. p. b-7, F-330, p. f-7) or

- Indirect alteration resulting from impacts of impervious surfaces, such as streambank erosion and channel incision from increased storm water volumes. (e.g., 4P MS-085 p. ms-5, 230, p. ms-4).

In the rural portions of the watershed, many headwater streams and creeks have been channelized. Many are eroding and becoming incised, some due to livestock access, some due to channelization (e.g., 4P BC-780, p. b-8; BC-555, p. b-3). Throughout the watershed, roadway ditches and gutters serve as the new headwater streams. (e.g., 4P BC-670 p. b-12)

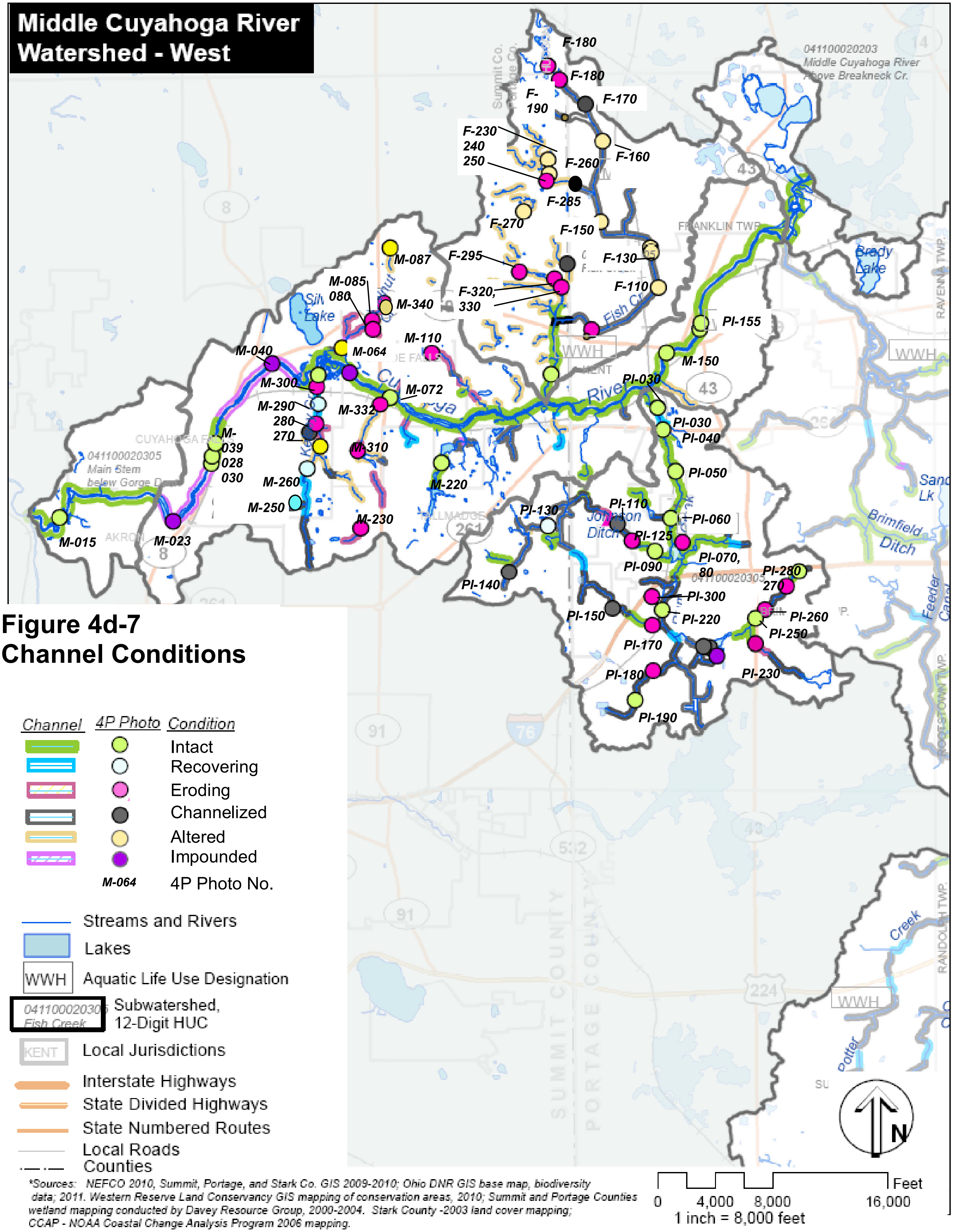


Figure 4d-7
Channel Conditions

Middle Cuyahoga River Watershed - East

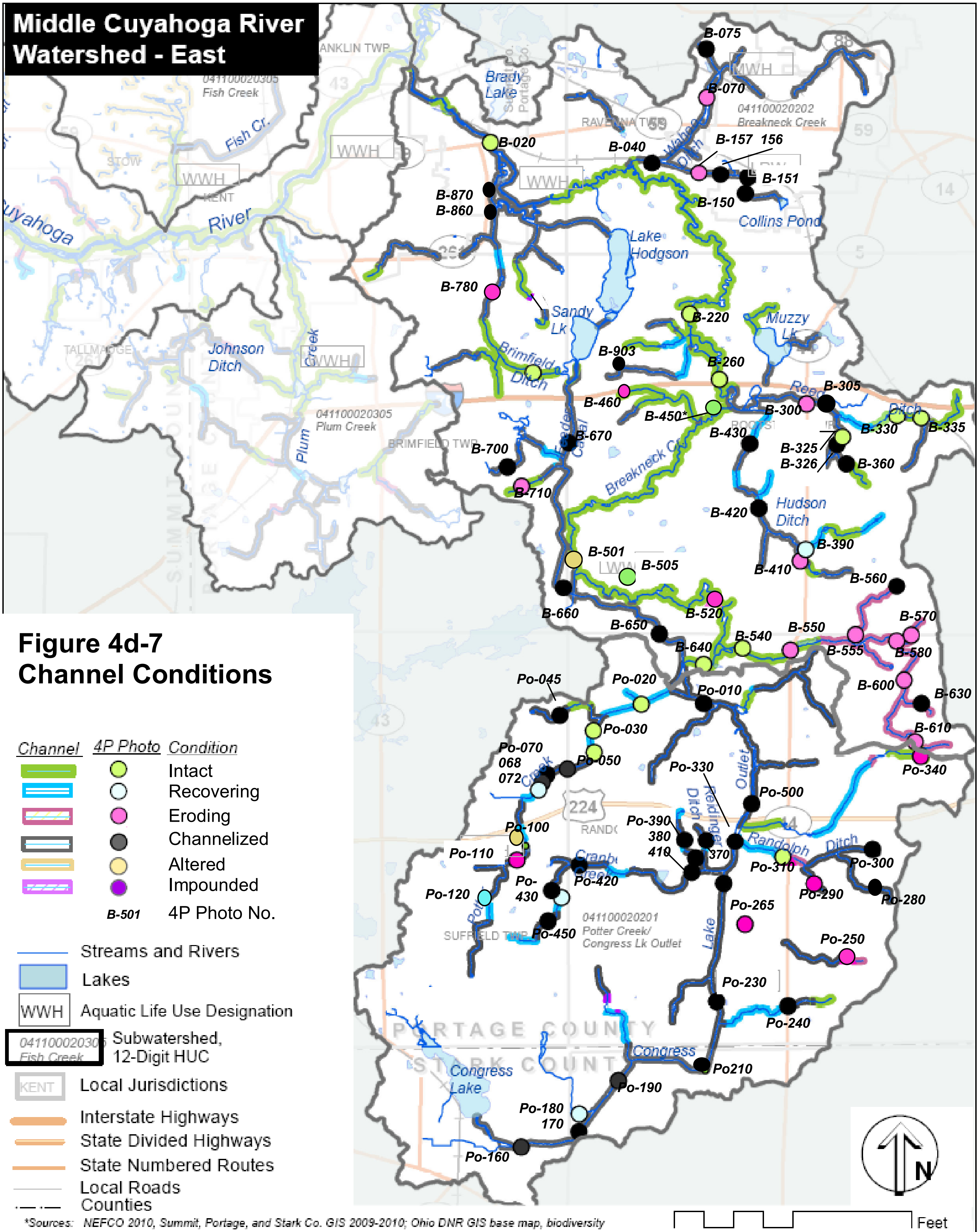


Figure 4d-7
Channel Conditions

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

Table 4d-1
Channel Conditions*

	Estimated length (in miles) of condition along channel					
	Main Stem					
Subwatershed	*Cuyahoga River*	*Other tributaries*	**Fish Creek**	**Plum Creek****	**Breakneck Creek**	**Potter Cr.**
Intact	12.8	2	1.4	4.7	25.3	2.8
Recovering	0	1.5	0	1	4.7	7.5
Channelized	0	3.8	6.7	11.9	36.8	29.5
Eroding	0	4.9	0.1	0.4	6.6	1.5
Eroding - livestock	0	0	0	0.1	0.2	0.7
Altered riparian area, hydrology, or channel	0	5.6	8.8	0.2	10.6	0
Impounded	3.1	0.3	0	0	0.1	0.1
Undetermined	0	0	0.8	4.1	0	2.8

*Observed from 2006 aerial photographs and limited visits to road crossings; generally do not count impoundments, except for the dam pools along the Cuyahoga River and limited sections of impounded tributaries. In several instances, channels could be categorized as several types, e.g., channelized and eroding, but the channels were only counted in one category. Totals are estimates based on general conditions. Planning for specific actions would require field verification.

** Along Plum and Breakneck Creeks, much of the intact corridor is along the main stem.

However each subwatershed also contains important intact riparian corridors, wetlands, and woods that are providing protection and are likely reducing impacts. Some are extensive riparian corridors, others are more isolated remnants along the stream corridors. These riparian corridors are areas to focus preservation and enhancement efforts. (P4 B-045, p. b1)

Each subwatershed also offers opportunities to restore or improve watershed functions to some degree, such as:

- Restoration of floodplain access, wetlands, stream channel morphology, or riparian vegetation;
- Increasing the use of best management practices in developed, developing, agricultural landscapes, or along roadside ditches, or
- Reducing imperviousness and increasing infiltration.

In each of the subwatersheds, there are areas that have been protected or where best management practices are being used to some extent. Within some parks and less densely developed areas, the more intact buffers offer protection. NRCS staff have been working with farmers to improve use of best management practices. Local communities have begun watershed protection or restoration efforts, removing dams, installing rain gardens, adopting riparian protection ordinances, purchasing land for conservation. The Middle Cuyahoga River Watershed efforts should build on these efforts to protect the intact systems, reduce future impacts, and improve the altered systems.

Main Stem

Approximately three miles of impoundment remain on the main stem. (4P MS-023, p. m-1, 057, p. m-2) Outside the dam pools, the channel of the main stem is largely intact, with its wooded riparian corridor recovering in the former dam pools (e.g., 4P MS-015, p. m-1, MS-148, p. m-3). The river has improved greatly with the removal or alteration of two dams. (4P MS-072, 150, p. m-3). The available floodplain in the predominantly narrow valley appears to be accessible along much of the river. Substantial portions of the main stem are fringed by undeveloped land, which is held in parks or is difficult to develop due to slopes and limited access or infrastructure. The channel should continue to improve as more dams are removed and as vegetation becomes re-established along the river margins outside of the downtown areas of Cuyahoga Falls and Kent. The unprotected riparian buffer along the river should be preserved.

With a high degree of development and imperviousness and steep slopes in this subwatershed, most of the main stem tributaries channels are altered, lack riparian buffers (other than sod), and have become incised. (4P MS-110, p. m-4, MS-332, p. m-6). Flooding problems have been noted at the upper and lower reaches of Walnut Creek, where development occupies former floodplains and wetlands. A few remaining undeveloped parcels could be used to improve hydrology, flood control, stream form, and habitat locally, reducing volume and sediment entering the river. Examples include Kelsey Creek and unnamed tributaries in Munroe Falls.

Tributaries flowing through wooded buffers appear to be relatively intact and offer better habitat. The tributary flowing through the Munroe Falls MetroPark appears to be the highest-quality habitat of this sub-watershed (MS-220, p. 6). Where Kelsey and Walnut Creek flow through wooded parks, their condition appears improved, although both show signs of impact from the high quantities of urban runoff. (4P MS-250, p. m-5, MS-085, p. m-4) The existing parks, Cuyahoga Falls golf course and land held by homeowners' associations offer opportunities for stewardship and improving riparian conditions.

Fish Creek

The lower portion of Fish Creek has an intact wooded corridor and appears to have much of its natural stream channel intact. (4P FC-020, p. f-1) Anecdotal reports from nearby residents note that the water flows more rapidly and clears out more quickly after storms since the Munroe Falls dam was removed, possibly reflecting the lower base level of the mouth and thus steeper slope of this tributary.

The upper portion of Fish Creek has been highly altered. Along most of its length, the channel appears ditchlike and heavily embedded with silt. Extensive wetlands have been altered both in Portage County and Summit County, reducing floodplain access, flood storage capacity, water quality treatment in the wetlands, and degrading habitat. (Photos 4P FC-080, p. f-2, 150, p. f-3; 240, p. f-6) Recent development has altered most of the tributary stream channels, directly by culverting, or indirectly, by altering the riparian corridor. (Photos 4P FC-330, p. f-7, 295, p. f-7)

The City of Kent owns substantial parcels along Fish Creek, which protects existing woods and wetlands and may provide an opportunity to restore altered channel or riparian landscape. In Stow, there are many small parcels held by homeowners' associations along streams where riparian plantings could be improved. In the undeveloped portion of the watershed, there may be opportunity to restore wetlands that were ditched for agriculture (or otherwise altered, as with playgrounds), either where the agricultural use has ceased or along the less-used margins of the properties.

Plum Creek

Plum Creek is a mosaic of intact, altered, and threatened landscapes. The most intact portions are generally within a couple of miles at at the downstream end. The City of Kent has removed the dam below Plum Creek Park, has restored floodplain access, channel morphology, and has planted the riparian buffer (4P Pl-025, p. pl-1) The downstream portions of Plum Creek flow through intact riparian wetland-floodplain complexes (4P Pl-040, p. pl-1). The Howe Ave./Jaycee park protects a substantial and diverse wetland system, but the stream is channelized through the wetland. (4P Pl-130, p. 3) Many other areas have been ditched through agricultural or residential land, offering no floodplain access or water quality treatment along the riparian corridor, and often resulting in erosion (4P PL-105, p. pl-2, 110, p. pl-3, pl-4, 210., p.pl-5) . Through golf courses and industrial parks, the creek often has unprotected riparian buffer (4P Pl-180, p. pl-4). Eroding banks are apparent along Johnson Ditch and in the densely developed commercial and community center of Brimfield. (4P Pl-260, p. pl-6) The lake at the center of the "Pleasant Lakes" development receives water from all the ditched headwater tributaries. (4P Pl-080, p. pl-1)

This subwatershed was the most rapidly developing area prior to the economic downturn of 2007-2008, and is likely to be so again when the economy recovers, due to its access to Route I-76 and sewer and water infrastructure. Preservation of the intact riparian corridor is important in this subwatershed, as well as improving best management and riparian management practices on large parcels, and promoting development and agricultural practices that minimize stormwater and water quality impacts.

Breakneck Creek

The condition of the riparian corridor, wetlands, floodplain access, and stream channel morphology vary throughout this subwatershed. Breakneck Creek itself appears largely intact. (4P B-045, p. b-1; 220, p. b-2.) The extensive riparian wetland-floodplain systems along the creek have buffered the effects of the altered landscapes upstream. The Feeder Canal is channelized.

The tributary ditches tend to be channelized with no floodplain access, reducing flood storage capacity. Erosion is occurring along Hudson Ditch and at the downstream end of Reed Ditch, in Brimfield Ditch, along the channelized headwater tributaries upstream of Congress Lake Outlet, and along portions of Wahoo Ditch (4P B-555, p. b-3; 610, p. b-4; 070, p. b-9; 300, p. b-6). Portions of the channels appear to be recovering, as well. Outside the municipalities, there are no riparian setbacks to protect the riparian areas from encroachment.

Damaging flooding problems have been noted at Collins Pond in Ravenna, which is now connected only by culvert to the Wahoo Ditch drainage system (4P B-160, p. b-10, 170, p. b-11), along Wahoo Ditch near Route 59 (4P B-070, p. b-9), and near the confluence of Breakneck Creek and Brimfield Ditch. Reed and Hudson Ditches are largely channelized and appear to collect large volumes of stormwater from the developed landscape, becoming incised at their downstream ends (4P B-305, p. b-6; 420, p. b-5; 430, p. b-5; 360, p. b-7).

Downstream of the confluence of these ditches with Breakneck Creek, the creek appears to be experiencing erosion due to high volumes of water. (4P B-260, p. b-2) A large wetland system at the confluence of the two ditches is likely providing substantial flood storage. Hudson ditch appears to be channelized through the wetland, reducing the flood-storage and treatment available. Preservation of this area and potentially restoring some connection to the wetland may help continue to reduce the influence of these ditches on the creek.

It is important to protect the undisturbed riparian corridor protecting Breakneck Creek and its tributaries. Along the ditches, there may be room to improve flood storage, hydrology, or water treatment, in undeveloped parcels. Use of green infrastructure would be important in the urbanized areas to reduce stormwater loading into the channels.

Potter Creek

Congress Lake Outlet is channelized. Portions of Potter Creek and its tributaries appear to be intact or recovering (4P Po-020, p. po-1; 050, p. po-1; 72, p. po-2; 180, p. po-9). Much of the channel length has been channelized for agriculture (Po-070, p. po-2, Po-420, p. po-6; 430, p. po-6; 380, p. po-7), and there are varying degrees of buffer being used to protect the streams. Erosion is apparent at an unrestricted livestock access along Randolph ditch (4P Po-310, p. po-8) and along some unmapped streams that cross Randolph Ditch. Congress Lake tends to be eutrophic, and the upstream end of Congress Lake Outlet also appears to have high amounts of weeds and algae. (4P Po-170, p.po-5)

Based on observations, substantial portions of Congress Lake Outlet, Randolph Ditch, Reidinger Ditch, Cranberry Creek, are channelized as ditches and appear to lack floodplain access. Some of the headwaters and other tributaries appear to be intact, recovered, or in two-stage ditches.

The wetlands along the lower end of Potter Creek are important to protect, as they are providing some of the only wetland treatment for the tributary. It would be beneficial to improve the level of riparian function and best management practices were possible along the tributaries.

4d Physical Attributes of Streams

- 3 Forested Riparian Corridor Assessment

Forested Riparian Corridor Assessment: Background

Background: Forested Riparian Corridor Assessment

One of the landscape elements providing great benefit to stream corridors is the quality of the riparian zone and riparian buffer. As noted in the Section 4d Background, the riparian zone is the transition zone between wetland and upland, where, often, the plants are rooted in groundwater that is in direct contact with the stream. The riparian buffer is undisturbed land adjacent to the stream corridor, which may be wetland or upland.

Functions provided by intact riparian zones and buffers include:

- Slowing down and storing storm water
- Absorbing, infiltrating precipitation
- Nutrient uptake
- Filtering sediment, allowing it to settle
- Bank stability
- Habitat
- Cooling

Wetlands and forested riparian zones are nearly equal in their ability to remove nutrients. (Lake Erie Nutrient Task Force Report, 2010.) Wooded riparian areas provide greater bank stability and cooling. Where stream systems are vertically stable, wooded banks help maintain a stable form. However, where unforested banks are not vertically stable, it would be unwise to simply plant trees and stabilize an undesirable form. If incremental improvements were sought for a stream with a degraded form, it may be more appropriate to establish grasses, shrubs, wetlands or floodplains first to improve functions such as form, hydrology, nutrient uptake or sediment removal, then later consider establishing trees if the stream form recovered.

Numerous studies have documented the value of riparian buffers and the effect of width on function. Generally, it is agreed that smaller headwater streams require much smaller buffers than or those with larger watersheds. The specific widths differ between studies. However, generally buffers of 25-30 feet are considered the minimum needed to protect headwater streams. Summit County’s riparian ordinance requires setbacks of 75 feet for watersheds up to 20 square miles, 100 feet for watersheds up to 300 square mile, and 300 feet beyond that. These ranges are similar to recommended distances in riparian setback literature.

Land cover was mapped with CCAP data within buffers of varying widths of water courses to determine if there were substantial differences in inner versus outer buffer land cover. The land cover percentages were similar, so for the purposes of this analysis, land cover within 75 feet was mapped. The mapped land cover may not reflect conditions on the ground, as CCAP data has data units of 30 m (approx. 100 feet) on a side. The results of this mapping indicate areas where land cover is likely to be beneficial to the stream (e.g., wetlands, woods) or may be encroaching on the integrity of the stream corridor. Limited observations were conducted at road crossings, but more in-depth field assessments will be needed in all cases to determine actual conditions. Land cover was measured in acres and calculated as percentages. The length of stream channel adjacent to the land cover was estimated applying the percent of land cover to the length of the streams estimated in the channel condition section. This is a rough estimate and may not accurately reflect disturbed versus intact or undisturbed buffer. The pixels are 30m on a side, which does not allow small features to be distinguished. In addition. There may be some narrow areas of woods that occur along the streams but would not be considered undisturbed. However, this estimate is adequate for general comparison.

This analysis focuses on riparian *buffer*, which can be mapped at the subwatershed scale, to some extent. Determining the condition (intactness) of riparian *zones* can be attempted with high resolution topographic information and photographs but often requires field work to determine conditions on the ground.

Findings:
Forested Riparian Corridor Assessment

Findings: Forested Riparian Corridor Assessment

Figure 4d-8 and Table 4d-2 summarize land cover mapped by the NOAA Coastal Change Analysis Program within 75 feet of the streams. Figure 4d-8 also shows the location of example Section 4P photograph sites within the mapped buffers. Large areas of intact wooded riparian corridor are present along the Main Stem, Breakneck Creek, Feeder Canal, and Plum Creek. Tributaries, Potter Creek, and Fish Creek tend to have more altered riparian corridors.

While the riparian corridor assessed acres of land cover, length of wooded riparian corridor could be estimated assuming that the area percentages translate to linear corridor. Table 4d-2 includes an estimate of linear miles of land cover along the riparian corridor.

- In the Main Stem subwatershed, mapping indicates that wooded riparian corridor is found only along 4 miles of tributaries and 5 miles of the main stem. However, these streams also flow through very steep valleys, which may limit the accuracy of the land cover mapping by satellite.
- In the Fish Creek subwatershed, approximately 4 miles (less than one-fourth) of the corridor is wooded. Much of this is at the lower end of the creek.
- In the Plum Creek subwatershed, 11 miles (nearly half) is woods, scrub-shrub, or wetland. Most of this is along the main stem of the tributary, although the headwaters near the Mogadore Reservoir are surrounded by woods and wetlands.
- Approximately 40 miles of Breakneck Creek and its tributaries flow through wooded riparian corridors. Like Plum Creek, this is about half. Also like Plum Creek, the main stem of the creek has substantial wooded buffer, and both have severely altered tributaries.
- Approximately 9 miles of the Potter Creek riparian corridors are wooded or wetlands. Although this represents only about 20 percent of the watercourse length in the subwatershed, there are some areas of large and diverse wetlands along Potter Creek, and Congress Lake Outlet flows through some relatively undisturbed wetland/wooded areas.

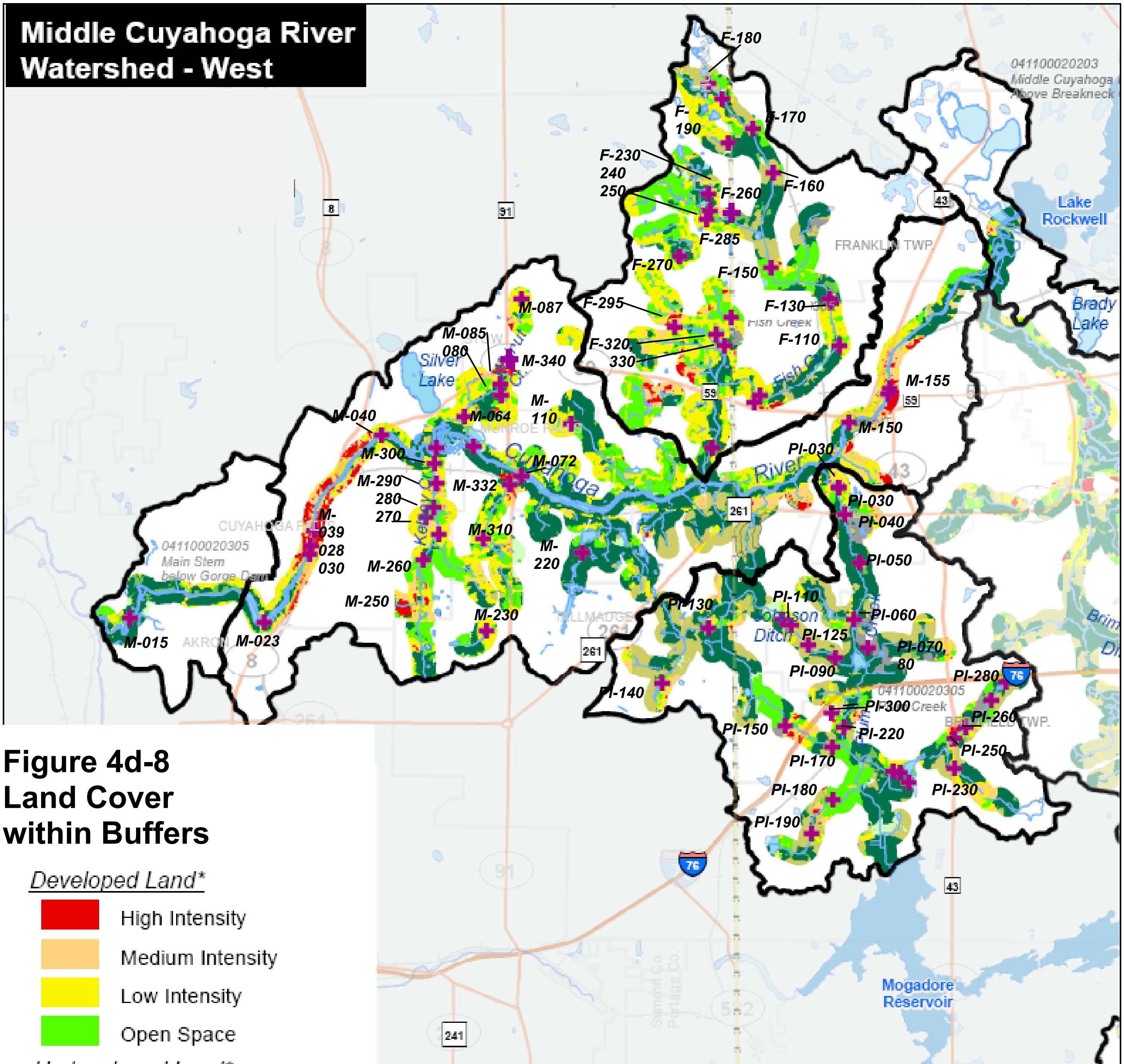


Figure 4d-8 Land Cover within Buffers

*Developed Land**

- High Intensity
- Medium Intensity
- Low Intensity
- Open Space

*Undeveloped Land**

- Agricultural
- Grassland
- Forest/Wetland
- Scrub/shrub
- Open Water

4P Photo Location

PL-230 Photo No.

Streams and Rivers
Lakes
WWH Aquatic Life Use Designation
041100020305 Fish Creek Subwatershed, 12-Digit HUC

KENT Local Jurisdictions
Interstate Highways
State Divided Highways
State Numbered Routes
Local Roads
Counties

N

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

**Developed land intensity based on imperviousness (e.g. buildings, parking lots, roofs): High - 80-100% (e.g., commercial/industrial, large parking lots); Medium - 51-79% ; Low - 21-50% Open Space - <20% impervious.*

**Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2011.*

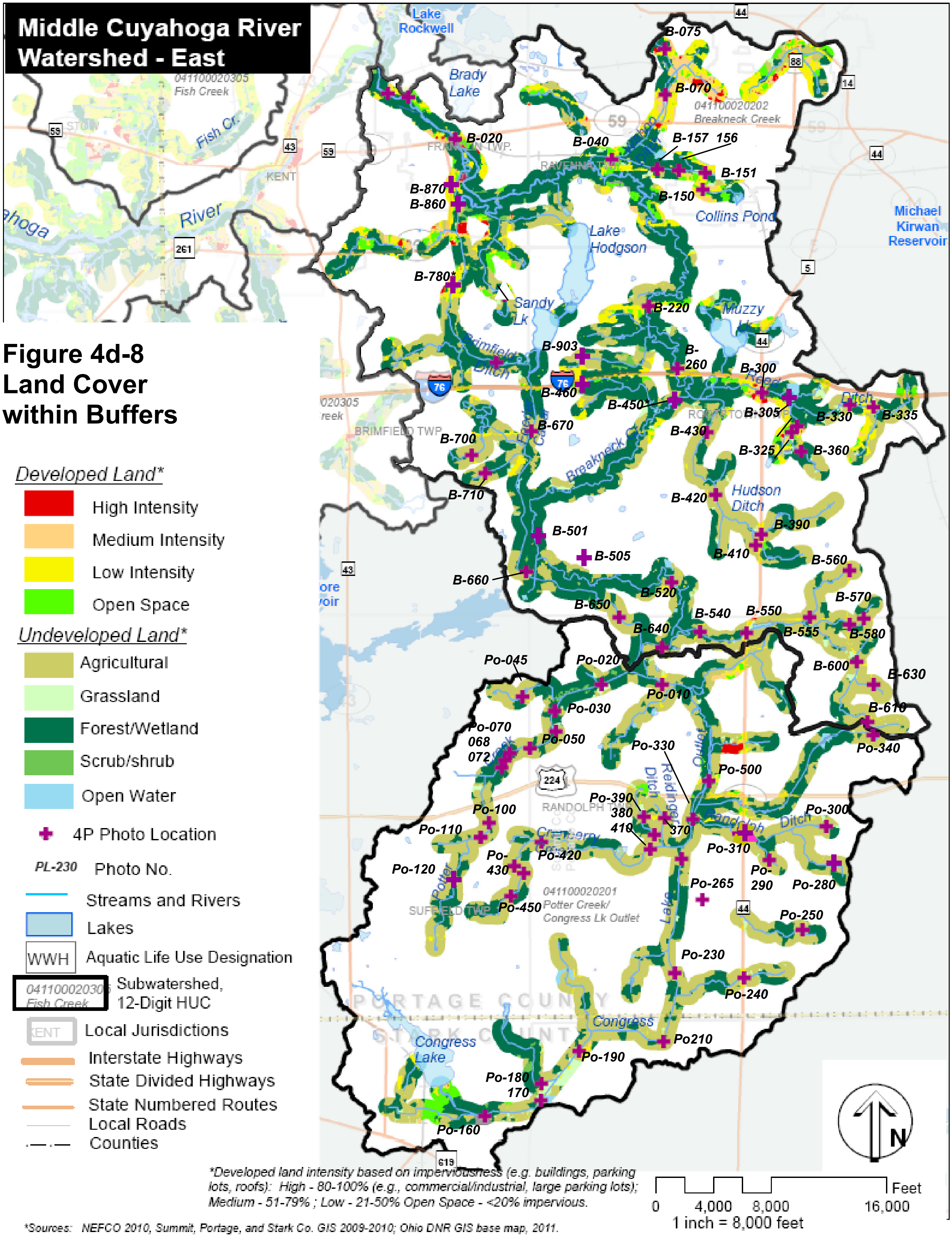


Figure 4d-8 Land Cover within Buffers

Table 4d-2
Land Cover in 75-foot Buffer

Main Stem Tributaries

Land Cover	*Walnut Creek* Acres	*Walnut Creek* Percent	*Kelsey Creek* Acres	*Kelsey Creek* Percent	**Main Stem tributaries** Acres	**Main Stem tributaries** Percent	**Main Stem tributaries** Miles*	**Cuyahoga River** Acres	**Cuyahoga River** Percent	**Cuyahoga River** Miles*
High density development	11	0.7%	17	1.4%	1	0.1%	0	144	2.9%	0
Moderate density development	19	1.2%	81	6.5%	85	8.5%	2	291	5.9%	1
Low density development	1,507	92.6%	733	58.6%	483	48.6%	9	2,037	41.2%	7
Developed open space	36	2.2%	295	23.6%	37	3.7%	1	490	9.9%	2
Cultivated Crops	0	0.0%	0	0.0%	6	0.6%	0	0	0.0%	0
Hay/Pasture	0	0.0%	0	0.0%	158	15.9%	3	11	0.2%	0
Grass	0	0.0%	2	0.2%	0	0.0%	0	7	0.1%	0
Deciduous Forest	45	2.8%	114	9.1%	201	20.2%	4	1,353	27.4%	4
Evergreen Forest	0	0.0%	1	0.1%	0	0.0%	0	0	0.0%	0
Mixed Forest	0	0.0%	0	0.0%	0	0.0%	0	0	0.0%	0
Scrub-shrub	0	0.0%	0	0.0%	1	0.1%	0	27	0.5%	0
Forested Wetland	9	0.5%	4	0.3%	21	2.1%	0	361	7.3%	1
Scrub-shrub Wetland	0	0.0%	0	0.0%	0	0.0%	0	0	0.0%	0
Emergent Wetland	0	0.0%	0	0.0%	0	0.0%	0	55	1.1%	0
Barren		0.0%	0	0.0%		0.0%	0	0	0.0%	0
Water		0.0%	3	0.2%		0.0%	0	167	3.4%	1
Total	1,627		1,252		992		18	4,944		16

Land Cover	**Fish Creek** Acres	**Fish Creek** Percent	**Fish Creek** Miles*	**Plum Creek** Acres	**Plum Creek** Percen	**Plum Creek** Miles*	**Breakneck Creek** Acres	**Breakneck Creek** Percent	**Breakneck Creek** Miles*	**Potter Creek** Acres	**Potter Creek** Percent	**Potter Creek** Miles*
High density development	84	0.8%	0	16	0.3%	0	46	0.3%	0	40	0.3%	0
Moderate density development	322	3.1%	1	65	1.4%	0	534	3.6%	3	18	0.1%	0
Low density development	4,874	47.1%	8	355	7.5%	2	1,577	10.5%	9	171	1.2%	1
Developed open space	1,802	17.4%	3	425	9.0%	2	258	1.7%	1	192	1.4%	1
Cultivated Crops	418	4.0%	1	220	4.7%	1	2,237	14.9%	13	5,452	39.4%	18
Hay/Pasture	544	5.3%	1	1,103	23.3%	5	2,651	17.7%	15	4,989	36.0%	16
Grass	51	0.5%	0	72	1.5%	0	79	0.5%	0	134	1.0%	0
Deciduous Forest	1,717	16.6%	3	1,713	36.1%	8	5,017	33.4%	28	2,219	16.0%	7
Evergreen Forest	10	0.1%	0	4	0.1%	0	28	0.2%	0	117	0.8%	0
Mixed Forest	2	0.0%	0	3	0.1%	0	6	0.0%	0	5	0.0%	0
Scrub-shrub	123	1.2%	0	39	0.8%	0	44	0.3%	0	18	0.1%	0
Forested Wetland	328	3.2%	1	548	11.6%	3	2,074	13.8%	12	727	5.3%	2
Scrub-shrub Wetland	2	0.0%	0	0	0.0%	0	48	0.3%	0	26	0.2%	0
Emergent Wetland	19	0.2%	0	0	0.0%	0	16	0.1%	0	8	0.1%	0
Barren	27	0.3%	0	134	2.8%	1	0	0.0%	0	58	0.4%	0
Water	18	0.2%	0	43	0.9%	0	395	2.6%	2	292	2.1%	1
Total	10,342		18	4,738		22	15,012	100.0%	84	14,467		45

*Estimated by totaling the length measured for channel conditions.

Miles of wooded versus disturbed stream bank would be double the channel lengths. This is a rough estimate, because wooded riparian corridor was often not evenly distributed on both sides of a stream channel, and measurement of narrow wooded areas may not adequately reflect whether they function as disturbed or undisturbed wooded areas. However, these estimates, combined with the mapping, may provide direction in re-establishing wooded corridors.

The mapping of the wooded riparian corridors appears to be reflected in the observed conditions in the stream channels. Based on the limited observations at road crossings, in many cases, the stream systems with intact riparian landscapes (woods or wetlands) appear to have a relatively stable form with riparian zones, well-formed banks, and substrate that may be conducive to warm water species (e.g., gravel), where the flows are high enough (Breakneck, which generally has high quality, is such a low-gradient stream it tends to be silty). In some cases, the stream appears to have recovered somewhat, possibly reflecting reforestation and lack of disturbance. (e.g., 4P Po-030, p. po-1; 072, p. po-2; MS-220, p. ms-6, PL-090, p. pl-2)

Where the mapping indicates that the riparian corridor has been altered to other uses (e.g., developed open space, residential, or agricultural) tributaries are often – but not always – degraded:

- Incised - possibly reflects excessive water loads and the lack of stabilizing riparian vegetation. (e.g., tributaries in Fish Creek, Main Stem, Breakneck Creek, subwatersheds) (e.g., 4P BC-610, p. b-4; FC-330, p. f-7; MS-110, p. ms-6; 132, p. ms-6)

- Silted in- from eroding stream banks and a channel that has eroded down and wider and is no longer able to generate adequate flows to remove fine-grained sediment or deposit sediment on floodplains. These are found along Wahoo Ditch, portions of Potter Creek, Cranberry Creek, and ditches and tributaries in the Breakneck, Plum, and Potter Creek watersheds (e.g., 4P BC-040, b-9; Po-070, p. po-2).

- Along many tributaries that have buffers mapped as “developed open space,” riparian vegetation has been replaced by sod, which provides only minimal watershed function. , The riparian corridor has been altered, but the stream still retains a form that appears stable over the short term. The short, dense root zone of sod and the compacted soil allows very little infiltration and provides almost no bank stability, reduction of flood energy, or pollutant uptake and are likely to degrade. Such areas occur in parks, golf courses, cemeteries, campuses and other large parcels, residential areas, and near many public or quasi-public buildings, and are apparent in the developed portions of all subwatersheds. If these areas can be planted with more appropriate riparian vegetation, it may be possible to prevent costly erosion and restoration problems. (PL-180, p. pl-4; Po-100, p. po-2).

- Along tributaries with buffers mapped as pasture or cropland, the condition of the riparian buffer varies. In some cases, a narrow vegetated buffer remains. In some, the agricultural producer has installed filter strips or has fenced off livestock, providing some protection to the channel. In some, the stream may actually be recovering within a deeper channel. In other cases, the agricultural uses extend almost entirely up to the stream channels. (4P Pl-105, p. pl-2; 110, p. pl-2; Po-240, p. po-9, 390, p. po-7; 110, p. po-3)

The mapping of buffer land cover can be used to target areas for further investigation and possible restoration or improvement. For instance, in areas mapped as developed open space or lower intensity uses, it may be possible to improve vegetative buffer conditions by planting shrubs or trees. In agricultural areas, it would be worth conducting field work and outreach to determine if the producer is using grassed buffers that do not appear on photographs, and whether the producer would be willing to use buffer practices that offer greater protection.

4d Physical Attributes of Streams
- 4 Permanent Protection

As noted in Section 4a-iv, permanent protection in this watershed includes:

- Riparian setbacks – in place in Tallmadge, Munroe Falls, Kent, Ravenna, and Brimfield. Their effectiveness depends on enforcement practices and the specific requirements.

- Conservation Lands – State Nature Preserves at Kent Bog (Cooperider Bog) and Triangle Bog

- Park districts – three parks in Summit County, two in Portage County

- Easements, as shown on Figure 4a-21, are limited.

4d Physical Attributes of Streams
- 5 Altered Stream Network

The stream form and networks develop in response to – and in equilibrium with – the surrounding landscape, influx of water and sediment, and substrate. Many of the important stream functions noted in the introduction to this section are related to an intact stream network and elements of the stream form. This section discusses how the stream forms have evolved and been altered in the Middle Cuyahoga River watershed.

As noted previously, the Middle Cuyahoga River watershed and many of its stream systems have been substantially altered over time, beginning with ditching, canals, and dams, and continuing with recent development and alterations for drainage or agricultural use. In many cases, these alterations reduce the ability of the watershed landscapes to provide the functions necessary for healthy, resilient stream systems, e.g., to absorb precipitation and runoff, filter and absorb pollutants, store floodwater, reduce sediment loads, maintain stability of the stream channel and banks, and support suitable habitats and biological communities.

To show hydrology from approximately 100 years ago, digital versions of early 20th century US Geological Survey topographic maps were processed to suppress all colors but blue (hydrology), tiled together by matching roads and township lines, and overlain by a map of the watershed and current roads and townships. Hydrological changes in recent decades is apparent by comparing NEFCO mapping from the 1990s with current mapping.

Findings:
Altered Stream Network

Findings: Altered Stream Network
Figure 4d-9 shows the stream system mapped in the early 20th century by the U.S. Geological Survey. Overall, the basic patterns of drainage do not appear to have changed substantially from the early 1900s. However, there are also some notable changes. Some may reflect which features were visible and mapped, but some probably represent changed hydrology.

- Figure 4d-9 shows the Congress Lake Outlet but, inexplicably, not the Feeder Canal, both of which comprise the dug canal connecting Congress Lake with Lake Hodgson. As noted previously, a control structure at the lower end of the Potter Creek watershed allows flow from the Congress Lake Outlet to be diverted to the Feeder Canal on demand, which occurs only occasionally during summer (dry) months.

- It appears that many of the streams may have been straightened and channelized (e.g., the lower end of Breakneck Creek, much of Fish Creek, Wahoo Ditch, Cranberry Creek, Reed Ditch, Hudson Ditch, smaller tributaries, etc.)

- In some areas (e.g., upper Plum Creek watershed), it appears that ditches have been extended, most likely into former wetlands. (Historical accounts and mapping show extensive wetlands in the Plum Creek watershed that have been replaced by ditched streams.)

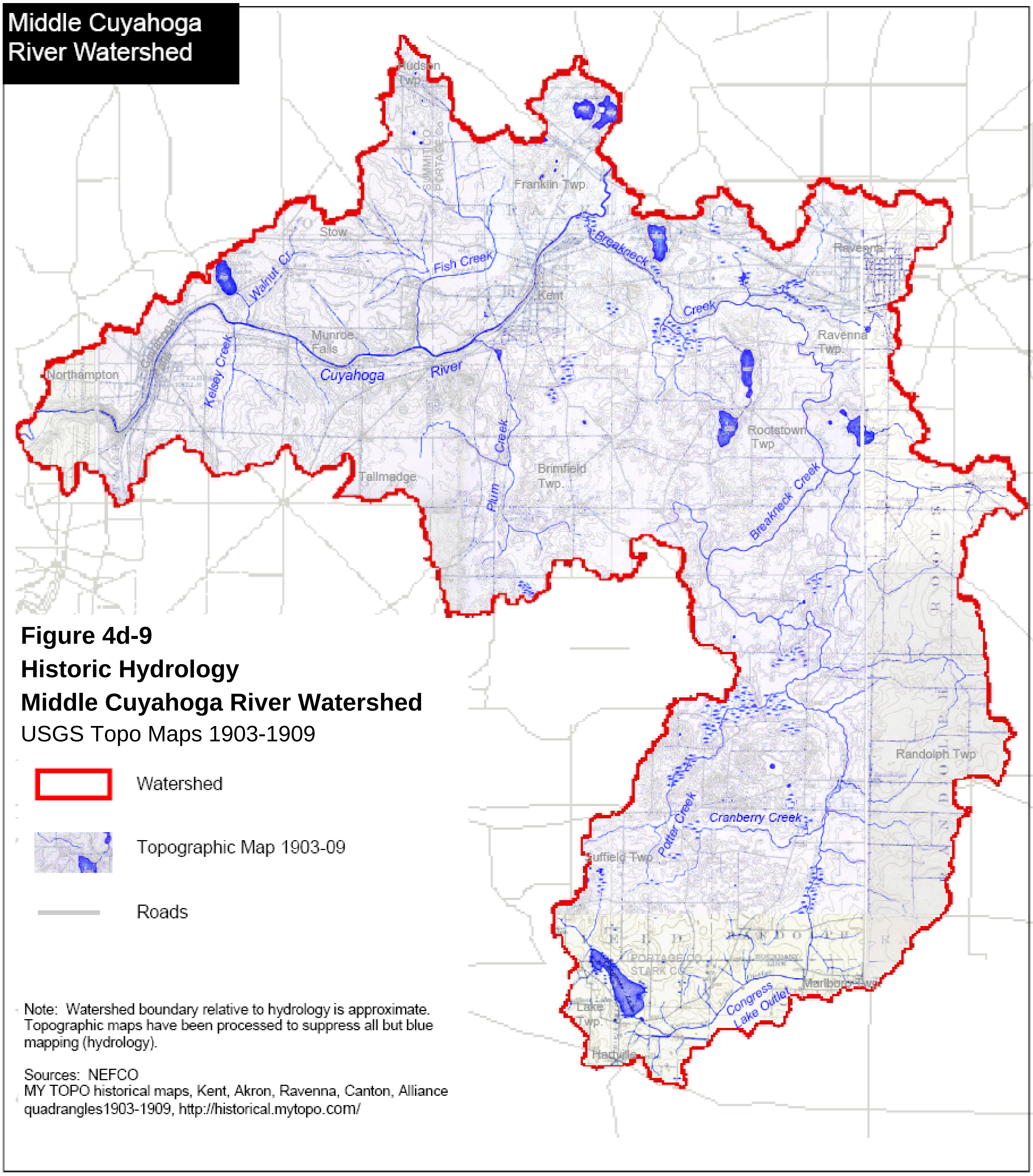


Figure 4d-9
Historic Hydrology
Middle Cuyahoga River Watershed
USGS Topo Maps 1903-1909

Note: Watershed boundary relative to hydrology is approximate. Topographic maps have been processed to suppress all but blue mapping (hydrology).

Sources: NEFCO
MY TOPO historical maps, Kent, Akron, Ravenna, Canton, Alliance quadrangles1903-1909, http://historical.mytopo.com/

- Once-continuous stream systems at Collins Pond in Ravenna and along Fish Creek have been segmented, as streams have been put into pipes. In the Fish Creek subwatershed, many of these changes occurred between the 1990s and 2006, as apparent from previous mapping of the area. (See Figure 4d-10). Stream systems have been further segmented by the presence of impoundments and storm water basins.

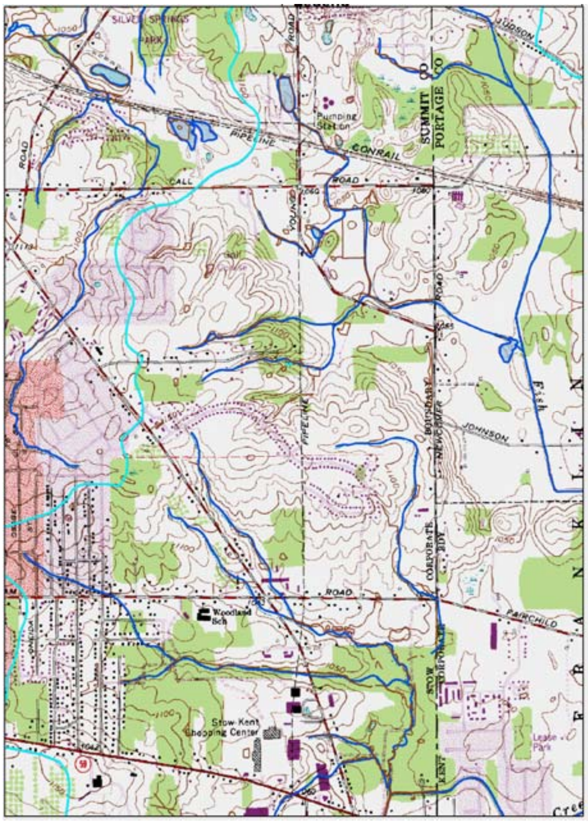
- There seems to be more water in the system. Areas that appeared as wetlands in the 1900s now appear as ponds. Streams that appeared to be ephemeral in the 1900s (e.g., Wahoo Ditch and Fish Creek) now appear to be perennial. Where streams formerly came together, there now appear to be large ponds to retain the water.

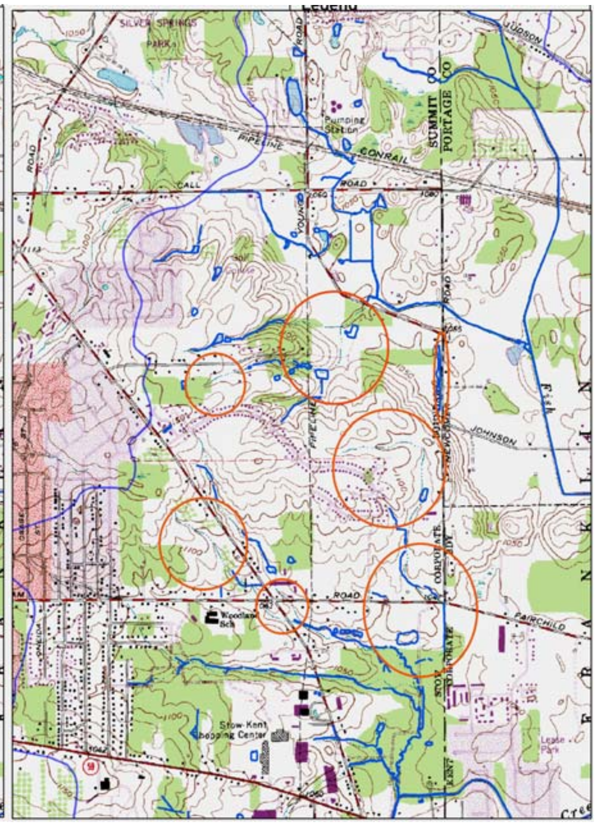
- In many of the areas that currently experience flooding problems in developed areas, the hydrology has been altered (e.g. Collins Pond, Brimfield Ditch/Breakneck Creek confluence, Walnut Creek headwaters.)

Headwater Streams

The character of headwater stream corridors has great importance to the water quality and the functioning of stream systems further downstream. Along numerous small headwater streams, water, pollutants, and energy enter the system. The riparian buffer, wetlands, floodplains, and riparian zone take up a relatively large area compared with the volume of water in headwater streams, and play an important role in moderating the amount and quality of the water coalescing downstream from the headwaters.

Studies of streams in their landscapes often quantify the density of streams in their watersheds, finding that the ratio of combined stream length to watershed size increases with soil runoff potential. In landscapes with relatively permeable soils, stream densities can be less than 1 km of stream length per square kilometer of watershed. As the landscape becomes less permeable (e.g., a change in soil types from sand to clay), more water runs off the landscape, creating a denser network of headwater streams.





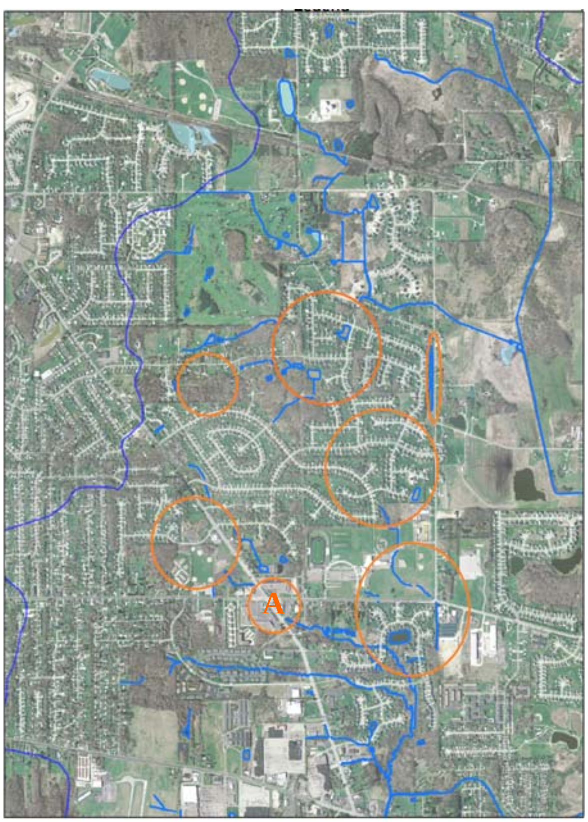


Figure 4d-10. **Hydrologic Changes Fish Creek Watershed.** The hydrology of Fish Creek tributaries has changed radically in just a few years as the watershed became developed. The upper two maps contrast the stream network from the 1990s (left) with 2006. The circles highlight areas where the hydrology has changed. At location "A" the stream has been covered by a parking lot and encased in a pipe.

The landscape of the Middle Cuyahoga River watershed has changed, becoming more impermeable with development and soil compaction. At first glance, it does not appear that the stream network has responded by generating more headwater streams. However, it is important to note that urban and roadway drainage in pipes, along streets, and in ditches, have become the new headwater streams. The density of the headwater stream network has, in fact, increased, since each road functions as a headwater stream. The volume of water entering the stream system has increased, and the large amount of altered landscape at the periphery of these new headwater streams precludes the important stream channel functions noted in Section 4d Introduction (e.g,. storm water absorption, filtering, flood reduction, sediment and nutrient uptake, energy transformation, cooling, and habitat).

Figure 4d-11
New Headwater Streams

The new urban headwater streams found in the developed areas contribute volume but do not provide any treatment provided by undisturbed riparian landscapes.

4d – Physical Attributes of Streams
- 6 Dams, Levees, and Petition Ditches

Dams

The main stem of the Middle Cuyahoga River has been characterized by dams and dam pools for over a century. Dams in the upper portion of the Middle Cuyahoga have already been removed or altered, restoring natural flow along the main stem, Plum Creek, and Kelsey Creek. (See Figure 4d-12). The remaining three dams on the Middle Cuyahoga River in Cuyahoga Falls are being considered for removal, which will restore free flow to a segment of the river that will likely return to rapids.

As shown in Figure 4d-12 numerous small dams still remain in the watershed. Dams are present on most if not all lakes, even though the watershed lakes are mostly naturally occurring kettles. Some of these may be left over from canal period water storage. The largest impoundments include:

- Lake Rockwell, which controls the City of Akron water supply,
- Lake Hodgson – the northern outlet is controlled by a dam
- Congress Lake, a privately owned recreational lake

In addition, there are several publicly owned smaller lakes controlled by dams, including:

- Munroe Falls Park, which impounds a recreational lake
- Muzzy Lake

For the most part, the remaining dams provide smaller recreational lakes and are privately owned.

Levees

The Middle Cuyahoga River and its tributaries do not have the extensive flood-control levees that characterize other rivers in Ohio. Considering levees to be structures that control overflow of a river or creek, the following areas have embankments or walls that control flow:

- A short portion of Walnut Creek in Silver Lake was contained within steel bulkheads to prevent the banks from collapsing in a development built in a wetland.

- Along the channelized portion of Fish Creek near Johnson Rd., the creek is lined with tall banks, presumably made from dredge spoil when the creek was channelized.

- The watershed contains a number of deeply carved ditches that no longer provide floodplain access, including Hudson and Reed ditches, Cranberry Creek, portions of Potter Creek, and Congress Lake Outlet/Feeder Canal.

Petition Ditches

There are four petition ditches in the watershed, all in Portage County. The largest is Wahoo Ditch. These are maintained as a district by Portage County. There is still the potential for improving flood storage (e.g., floodplain access) along petition ditches by working with the affected parties.

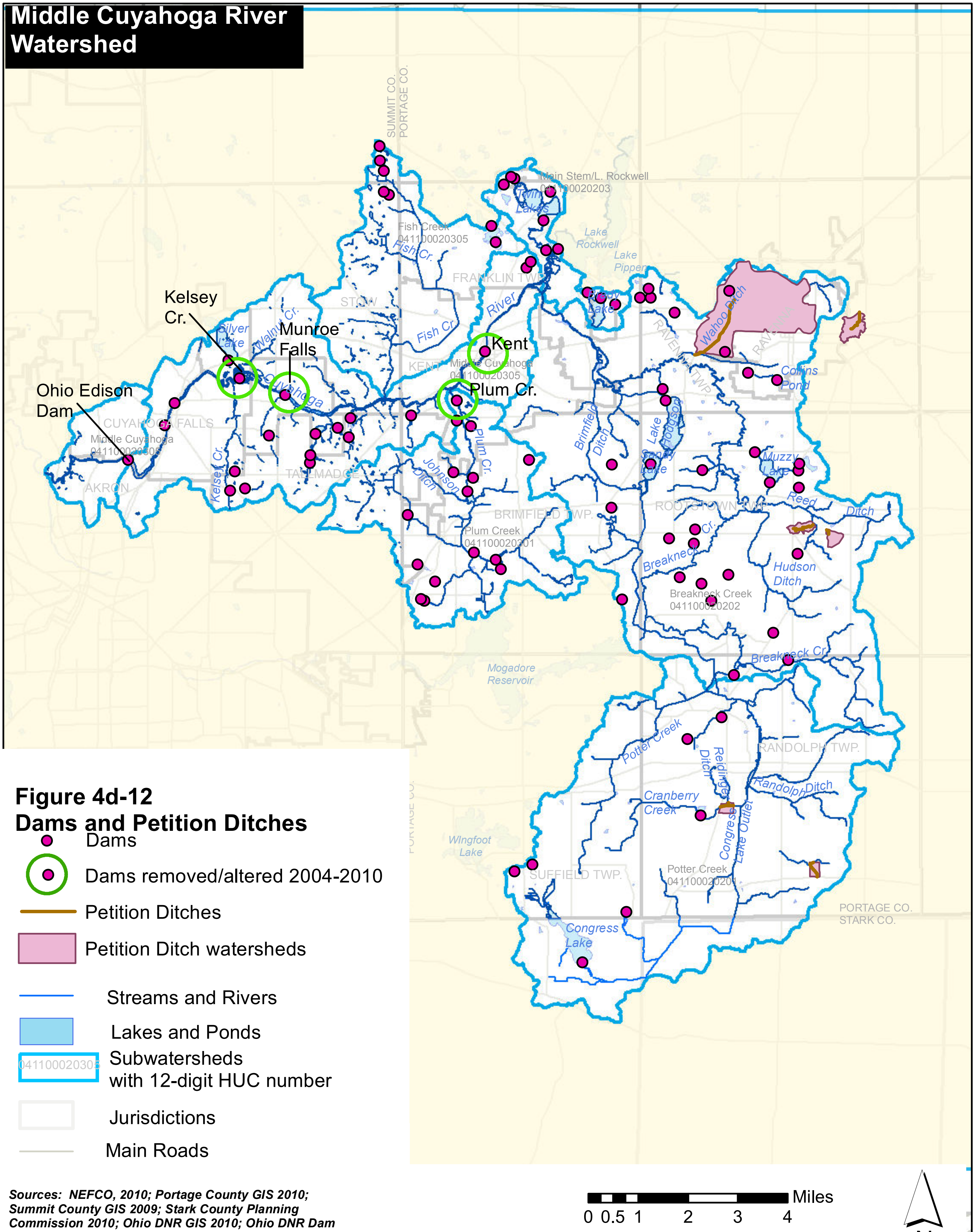


Figure 4d-12
Dams and Petition Ditches

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; Ohio DNR Dam Inventory 2010

4d- Physical Attributes of Streams
- 7 Status and Trends

The altered nature of the watershed has been highlighted in several sections. The intact segments include Breakneck Creek, lower Plum Creek, and the Cuyahoga River outside of the dam pools. These are areas to focus on for preservation.

Many of the remaining tributaries have been altered by ditching, urban development, removal of riparian vegetation, or erosion. The presence of wooded buffers seems to be correlated with improved channel quality, especially where the stream has not been channelized. These altered streams present opportunities for restoration or enhancement. Streams that have not yet begun to erode may offer opportunities to prevent erosion if planted with suitable riparian vegetation.

4d – Physical Attributes of Streams
- 8 Expected Development

At present, the development pressure that characterized watershed communities until 2007 has dwindled, and it is not clear when economic recovery will again spur growth in the region. When the pace of development increases again, it is likely that it will continue to occur in the general locations that had been growing during the previous growth period, i.e, primarily in Brimfield and Rootstown, the Plum Creek and Breakneck Creek subwatersheds, near Route I-76 and the available sewer service, quite possibly in the locations of the platted but unbuilt subdivisions. Any new development that occurs will be covered by stormwater management requirements in place at the time in terms of construction stormwater runoff.

4d – Physical Attributes of Streams
- 9. Expected Road Construction

The AMATS (Akron Metropolitan Transportation Study) develops long-term transportation plans for Summit, Wayne, and Portage Counties. Their long-term transportation planning includes:

- Continued improvements of safety, congestion management
- Continue to work with communities to reduce the burden of development on the transportation system
- Continued promotion of transit opportuntiies
- Limited additional capacity

Two construction projects are currently under way, as of June, 2011, reconstruction of the Crain Avenue bridge in Kent and traffic safety and flow improvements to Summit Road in Kent.

Future projects included in the watershed include primarily safety improvements with some limited capacity expansion on existing roads, including widening along Graham Rd. at Route 91 in Stow, Route 59 in Kent, Howe Ave. in Cuyahoga Falls. Other improvements anticipated include intersection improvements to improve safety, through stoplight modifications and turning lanes.

It is worth remaining aware of upcoming projects. A recent roundabout at Howe Ave. might have been an interesting site for some stormwater infiltration. Bridge projects or possibly road widening could accommodate bicycle traffic. However, most of the projects described in the long term highway recommendations do not lend themselves easily to additional water quality improvements due to their limited scope. It is also worth remaining aware of other road projects anticipated for the watershed, which could provide the need for wetland mitigation.

4e Designated Use and Attainment
-1 Water Quality Attainment, Causes and Sources of Impairment

Designated Use Attainment and Other Water Quality Concerns: Background

Designated Use Attainment and Other Water Quality Concerns - Background

The Ohio EPA conducts physical, chemical, and biological monitoring to determine

- the extent to which assigned use designations are being attained,
- whether the designations are appropriate and attainable, and
- whether there have been changes in physical, chemical, or biological indicators over time.

The assessments focus on biological indicators, because the biological communities reflect the long-term quality of the environment, water chemistry, and stream channel. The assessments also include physical and chemical characteristics and nuisance species that affect aquatic life use and other designations as well (e.g., recreation, water supply).

Habitat – QHEI - and other Biological Indicators

In evaluating the biological communities, the Ohio EPA determines four numerical indices based on the composition of the biological community and habitat characteristics. The premise is that the healthiest systems will have high diversity, an assemblage dominated by pollutant-sensitive species, and few if any species tolerant of pollution. Three of the indices reflect the biological community:

- Index of Biological Integrity (IBI) and the modified Index of Well-Being (MIwb), which focus on the response of the fish community (e.g., health, amount, diversity, and pollutant tolerance of the fish community); and
- Invertebrate Community Index (ICI), which assesses the community of macroinvertebrates (e.g., insects and insect larva, mollusks, snails, crustaceans)

For full attainment of WWH standards, streams and rivers must have biological community scores as follows:

IBI	37/40/40 – WWH Wading/boat-sampled/headwaters, respectively; 24 – MWH-C
MiWB	7.9/8.7 – WWH Wading/boat
ICI	34 – WWH wading/boat; 22 – MWH-C

Scores below the state standards indicate a degraded biological community. The range of scores of each category can help determine what is stressing the communities.

In addition, the biological assessment includes the Qualitative Habitat Evaluation Index (QHEI) method, which evaluates characteristics of the habitat and stream morphology. If the biological indicators suggest that the designated use is impaired, it may well be due to altered habitat. Conversely, if the biological communities are healthy, a reduced QHEI may suggest that the habitat is being degraded, and the biological community may be affected.

The QHEI assessment evaluates six general categories of stream channel characteristics, listed in Table 4e-1, which reflect the quality of habitat, likelihood that biological communities will attain water quality criteria, and to a great extent, the overall health or stability of the system. These variables can provide a positive or negative influence on biological communities and the overall health of a stream, and are scored accordingly in the QHEI as WWH attributes or MWH (modified) attributes, respectively. The target score for WWH is 60 or higher. Characteristics are also rated descriptively from very poor to excellent, based on the score.

Table 4e-1 Habitat Characteristics Measured in QHEI

Variable	Warm water habitat characteristic	Modified warm water habitat characteristic	High Influence MWH characteristic
Substrate*	Large particles clear of silt	Silt, embeddedness (degree to which silt fills in spaces between particles)	Embeddedness, silt/muck substrate
Channel characteristics	Sinuous	Straightened channel	Channelized, no sinuosity
Pool and Riffle quality	Pools > 40 cm, low-normal embeddedness	Lack of distinct pools & riffles	Max. depth < 40 cm
Riparian corridor	Vegetated with trees/ shrubs, floodplain access	Altered, denuded	
In-stream cover	Places for fish to hide – root wads, woody debris, boulders, overhanging banks	Few cover types, lack of in-stream cover	Sparse Cover
Drainage area and gradient	Fast current, eddies	No fast current	

*Ohio EPA has not developed standards for sediment as a pollutant, but the degree of embeddedness of the substrate acts as a surrogate indicator.

The highest scores for habitat, i.e., the most likely to support high quality warm water communities, are assigned to streams with pool-riffle sequences, well-formed banks, gravel substrate, cover in the form of boulders, woody debris, or undercut banks, stable banks, wide forested buffers, sinuous pattern, and accessible floodplain. As stream systems are altered, the indicators are degraded. A 1999 Ohio EPA technical bulletin, *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams (MAS/1999-1-1),* found that if two or more of the key indicators (e.g., substrate, channel form) are determined to be “modified” or “poor,” the water course is unlikely to support the appropriate communities to attain warm water habitat standards. As noted in Section 4d, the attainment of Warm Water Habitat standards thus depends in part on stream morphology.

When biological communities do not meet state water quality criteria, an assessment of habitat characteristics along with chemical parameters may indicate areas that should be improved. The 1999 Ohio EPA technical bulletin documents the correlation between biological communities (IBI) and habitat, noting that when only one or two key characteristics (scored as “high influence”) are modified, the habitat is unlikely to support WWH biological communities, as shown in Table 4e-2. The technical bulletin also identifies targets that can be used in improving/restoring physical channel characteristics in order to significantly improve habitat and biological scores.

Table 4e-2
Effect of Modified Attributes on Attainment of Water Quality Critera

	QHEI Attribute Scores for WWH Attainment	
Attribute	**WWH**	**EWH**
Number of modified attributes	4 or fewer	2 or fewer
High influence modified attributes	1 or fewer	0
Substrate metric score	13 or higher	15 or higher
Substrate embeddedness score	3 or higher	4
Channel metric score	14 or greater	15 or greater
Overall QHEI	60 or greater	75 or greater

Source: Ohio EPA, 1999

Determining Causes and Sources of Non-Attainment

Should a water course fail to meet biological criteria for its designated use, the Ohio EPA evaluates other conditions to determine what might be affecting the biological community (e.g., habitat, dissolved oxygen, turbidity, toxicity) and what the likely sources of the stressor are (e.g., dam pool, flow alteration, non-point sources from surrounding land uses, effluent, etc.). Each cause and source would be addressed by a different type of response.

Other Water Quality Concerns

While attainment of designated uses incorporates some measures of water body health, there are other relevant concerns in the watershed, including:

Sediment and Nutrients–Both sediment and nutrients are of great concern downstream due to their potential effects on Lake Erie and their effect on local waters. Sediment carries with it metals, toxins, and nutrients. Sediment damages habitat, increasing the potential for non-attainment and affecting stream functions such as oxygenation. Removal and disposal of sediment in navigation channels is a costly problem.

The Ohio EPA 1999 technical bulletin on stream health noted the importance of nutrient levels in the health of water bodies and attainment of water quality standards. Biological communities can be stressed with excess nutrients, and excessive levels can result in nuisance algae. Nutrient levels entering Lake Erie have been a concern since the 1960s, when the anoxic “Lake Erie Dead Zone” drew attention to the problem, and nuisance algal blooms fouled the shores. Limits on phosphorous in detergents and sewage treatment plant effluent, and improved farming practices reduced the input of nutrients to the lake problems of anoxia. However, recently, anoxic conditions and nuisance algal blooms have started to recur in Lake Erie during summer months, drawing attention again to the concern of nutrients and the sediment that carries them. A study published in 2010 indicated that changing agricultural practices in the Maumee basin were likely responsible.

Sediment and nutrients are addressed further both as part of this section and Section 4e-3, nonpoint source pollution, as appropriate.

Findings: Use Attainment by Subwatershed

Findings: Use Attainment

Conditions in the Middle Cuyahoga River and tributaries have been documented in several studies that compile data from various periods of monitoring. Table 4e-3 and Figure 4e-1 summarize the use attainment assessed over a period of approximately 20 years in the Middle Cuyahoga River and tributaries. The areas of study differ, reflecting the focus of each:

- The 1997 Technical Support Document (TSD) documented conditions between Lake Rockwell and the Little Cuyahoga River, as part of a study of the entire river.
- The 2000 Total Maximum Daily Load (TMDL) assessment focused on the area between Lake Rockwell (RM 57.7) and Water Works Park (RM 48.6)
- The 2007 TSD documents biological assessment of the same reach as the 2000 TMDL, following removal/alteration of the dams at Brust Park and Kent. In 2007, Ohio EPA monitored as far downstream as Waterworks Park but noted there was no significant change downstream of that point, since there was essentially no change to the downstream dam pools. The Munroe Falls dam site was re-surveyed in 2010 and found to be in full attainment of WWH criteria.
- The 2003 TMDL addressed the river downstream of Brust Park but focused primarily on the conditions below the Little Cuyahoga River. The 2003 Lower Cuyahoga River TMDL briefly addressed habitat, oxygen, and nutrient conditions from Water Works Park to the Little Cuyahoga. However, since there had not been significant changes to this reach, the 2003 document did not provide a detailed discussion of the condition of the dam pools but focused on the combined sewer overflows and downstream concerns. It is assumed that more recent monitoring and the 1997 and 2000 documents adequately reflect conditions between Water Works Park and the Little Cuyahoga River. Habitat alteration was listed as a non-load based impairing cause in the 2003 TMDL.

The assessments over the years, summarized in Table 4e-3, have documented the following:

- Degraded conditions in the Cuyahoga River dam pools,
- Substantially improved habitat and biota in former dam pools with restored flow,
- Intact habitat in Plum Creek and much of Breakneck Creek
- Habitat conditions in the upper portions of Fish Creek reflect its nature as a channel, in the lower portions of Fish Creek, habitat is not a limiting factor.
- Habitat in Kelsey Creek is “fair” (QHEI score 53.5) but may degrade further
- Habitat conditions in other tributaries have not been formally assessed. However, in Section 4d-2, apparent channel conditions are noted. Tributaries identified as eroding or channelized are likely affected by one or more of the high influence factors, may be degraded/degrading, and should be assessed further for contributing factors and opportunities. Tributaries identified as “intact” or “recovering” appear to have characteristics of intact channels and should be protected.

The most recent findings, of full attainment from Kent down to Munroe Falls on the main stem, reflect changes to the river after two dams were altered or removed in Kent and Munroe Falls in response to the 2000 Total Maximum Daily Load (TMDL) analysis. Prior results along the main stem are included for comparison, to demonstrate the dramatic improvements that occurred.

The Ohio Integrated Report includes the impairment listing, known as the Section 303(d) list, which identifies which water bodies are not in attainment of water quality standards and which require implementation of a TMDL to reach attainment. The causes and sources identified are included in Table 4e-3. The results, briefly, are as follows:

- Fish Creek/Cuyahoga River – Reporting status 4A – impaired, no TMDL needed. Priority points 6 out of 20. Watershed Score 60.7. Main stem recreational use score is 89.
- Plum Creek – Reporting status 1Ht – attaining designated use, historical data
- Breakneck Creek. Reporting Status 4Ah – impaired, no TMDL needed, historical data. Watershed score 22.2, Wahoo ditch monitored recently, non-attainment.
- Potter Creek – Reporting status 4Ah – impaired, no TMDL needed, historical data.

While most of the monitored waters in the watershed are impaired to some degree, they are generally a relatively low priority for TMDL. With the exception of the Cuyahoga River, they use historic data. The next monitoring for all is scheduled in 2020, with TMDLs due in 2023.

Table 4e-3
Water Quality Attainment

Subwatershed, HUC 04110002…, Segment, *Assess Date/Report*	**Desig. Uses***	**Location, RM (River Mile) and collection type (b = boat, w = wading)**	**ALU Attain/ 2010 AU score**	**IBI**	**MI wb**	**ICI**	**QHEI**	**Causes/Sources of Non-Attainment**	**Comments**
Middle Cuyahoga									
0203, *OEPA 2010 (sampled 2008), OEPA 2008, OEPA 2000a*	WWH, AWS, IWS, PCR	DST Lake Rockwell dam, 57.67	Partial/ 80					2010, 2000a. Organic enrichment/DO (high); habitat alterations (t); siltation; flow regulation/modification – development (high); minor munic. Point source (slight), land development (t), non-irrig. Crop production	*2008.* City of Akron has maintained flow > 3.5 mgd since resolution of lawsuit. 2000a. Most severe section of non-attainment immediately DST from L. Rockwell, assoc. with hypolimnetic dam releases.
Main Stem 0305, after dam removal/ alteration *Ohio EPA 2008 Ohio EPA 2010*	WWH, AWS, IWS, PCR	Data/sites from Ohio EPA 2008 Kent , Grant St. 55.6 b Kent , Brady's Leap 55.0 b Kent , Tannery Park 54.6/54.0 w Stow, Fish Cr WWTP 51.8/52.0 b Stow, DST FC WWTP 51.0 b MF, former dam site 49.0/50.0 b CF, Water Works Pk 48.7 b	Full Full full partial partial partial non AU score 55	46 42 41 30 32 31 23	8.3 8.2 8.5 7.5 8.4 8.7 6.4	36 36 36 50 NS 44 42	69 76 79.5 61.5 71 66.5 58	Dissolved oxygen throughout dam pool above MF dam meets criteria. - DST Kent - Fish populations recovering after MF dam removal - Scores below MF dam not significantly different than previous score 2010: causes/sources – habitat alteration, flow alteration, nutrients, organic enrichment, siltation, total toxics, unknown toxics; sources – channelization, CSO, dam, major municipal point source, natural, septic tanks, sewer line construction, urban runoff/NPS	Potential enrichment lingering dst of Lake Rockwell – as indicated in elevated phosphorous, nitrate+nitrite levels compared to state and EOLP criteria, invertebrate species, diurnal fluctuations in oxygen. No apparent effects on indicators yet, but nutrients should be monitored Remaining dam pools have not improved since previous studies.

Table 4e-3
Water Quality Attainment (cont'd)

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Main Stem *before* dam removal/ alteration *Ohio EPA 2000* Main Stem 1997 TSD (Ohio EPA 1999)	WWH, AWS, IWS, PCR	Kent – Grant St., 55.7 dp Kent – Tannery Pk, 55.2/54.4 - ff Kent – Middlebury, 53.4 - dp Stow – UST Fish Cr.53.0/52.6 dp Stow – DST FC WWTP, 51.0 dp MF – Dst dam, 49.7/49.8 - ff CF– Water Works Pk, 48.7/48.4 Dp CF – Dst Cuy. Falls 46.0/45.9 CF – Dst Edison dam 44.0 Akron – Ust Little Cuyahoga 42.8 (dp = dam pool, ff = free flowing)	Non Partial Partial Non Non Partial Non Partial Full Partial	28 28 31 31 30 34 22 28 35 38	8.2 7.6 7.7 7.7 6.2 8.4 5.0 6.7 7.6 6.9	Ns 44 38 18 NS 42 38 34 38 40	51 70 38 64 48.5 83.0 36 67 76 82	Low dissolved oxygen, low assimilative capacity, enriched in P relative to region, due to flow alteration/low stream flow	
Potter Creek 0201	WWH, AWS, IWS, PCR								
Potter Creek, *Ohio EPA 2010, Ohio EPA 2000a Data coll. 1996, 2000*	WWH, AWS, IWS, PCR	Potter Cr. at Trares 1.8/1.5	Partial/ Non AU score 80	24		34	41	Sediment from ag. runoff and poor channel development factors of non-attainment. Habitat/flow alteration (high); siltation (high); organic enrichment/DO (mod); sources: channelization – ag. (high); flow regulation/ modify-cation – development; nonirrig. crop production (high); major/minor municipal points source; natural limits	Segment recovering from past channelization. 2000 TMDL noted that Potter Cr. did not contribute significant COD or BOD to the main stem and that evolution/return to free-flowing state and recovery of riparian area may be enough to improve attainment.
- Congress Lk Outlet	MWH-C, AWS, IWS, PCR								
Breakneck Creek 0202									

Table 4e-3
Water Quality Attainment (cont'd)

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Breakneck Creek *Ohio EPA 2010* *Ohio EPA 2000a*	WWH, AWS, IWS, PCR	Breakneck Cr (Ohio EPA 2000) - ust WWTP, 2.6 – dst Franklin Hills WWTP, 2.5 – dst Franklin Hills WWTP, 1.6 Breakneck Cr (Ohio EPA 1997/2000) - DST Homestead Ave. 14.1 - Background/reference 9.5 - Reference site 6.8/6.9 - Ust. Wahoo Ditch 5.2 - Breakneck Cr. Ust Wahoo - Dst. Wahoo Ditch 3.1 - DST Franklin Hills WWTP 1.7/1.8 - DST abandoned landfill 0.1/0.5 –	 Partial Partial partial (Full) (Full) Partial Full Partial Non Non Partial 2000a: Partial, 2.0 full 9.5, non 3.8 2010 AU score 80	 44 40 42 -- 46 30 40 41 38 15 44	 7.1 6.3 7.2 -- NA NA NA 6.0 5.1 4.6 7.2	50 -- 44 46 -- 48 36 44	-- 67.5 66.5 68.0 -- 56.5 59 69	Upstream of WWTP full attainment except for one exceptionally pooled area. Dst of WWTP severe impacts to fish comm. Some recovery near confluence with Cuyahoga. Improvements since 1984. 2000a. Unknown toxicity (high); flow alteration (high); organic enrichment/DO (mod); major/minor municipal point source (high); natural (high)	2000a. Fish communities showed impacts from Ravenna and Franklin Hills WWTP. Future monitoring recommended.
- Feeder Canal	MWH-C, AWS, IWS, PCR								
- Lake Hodgson	PWS								

Table 4e-3 (cont'd)
Water Quality Attainment

Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Wahoo Ditch, *OEPA 2009, OEPA 2000a, Ohio EPA 2000 Data coll. 1996, 2009*	MWH-C, AWS, IWS, PCR*	RM 2.6 RM 2.5 RM 2.2 Wahoo Ditch DST WWTP (Ohio EPA 2000), RM 0.4	Non Non Non Non	Poor Poor Poor		24 22 26 Poor	Fair, Fair Good	Habitat alterations (High), organic enrichment (mod) unknown contaminants, urban runoff, channelization, sediment PAH, legacy contaminants, severe ditchlike condition; channelization and major municipal point source (2000)	2009 - Sediment PAH levels elevated above probable effect concen.; Channel embedded; DST site had cobble. 2000a – Extensively modified by channelization, choked with macrophytes, substrates several feet deep in silt and muck. Ammonia concen. elev. due to Ravenna WWTP on Hommon Ave. Ditch, but 1984 sampling showed similar poor conditions UST and DST of Hommon Ave. Ditch
- Hommon Ave. Ditch	LRW, AWS, IWS, SCR								
Plum Creek 0301 Ohio EPA 2010 (sample years 2000, 2005, 2006)	WWH, AWS, IWS, PCR		AU score 49					Causes: Direct habitat alteration, flow alteration nutrients, organic enrichment/DO, siltation, total toxicity, unknown toxicity Sources: channelization – development, CSO ?? dam construction, major municipal point source; natural; septic systems; sewer constr.; urban runoff	

Table 4e-3 (cont'd)
Water Quality Attainment

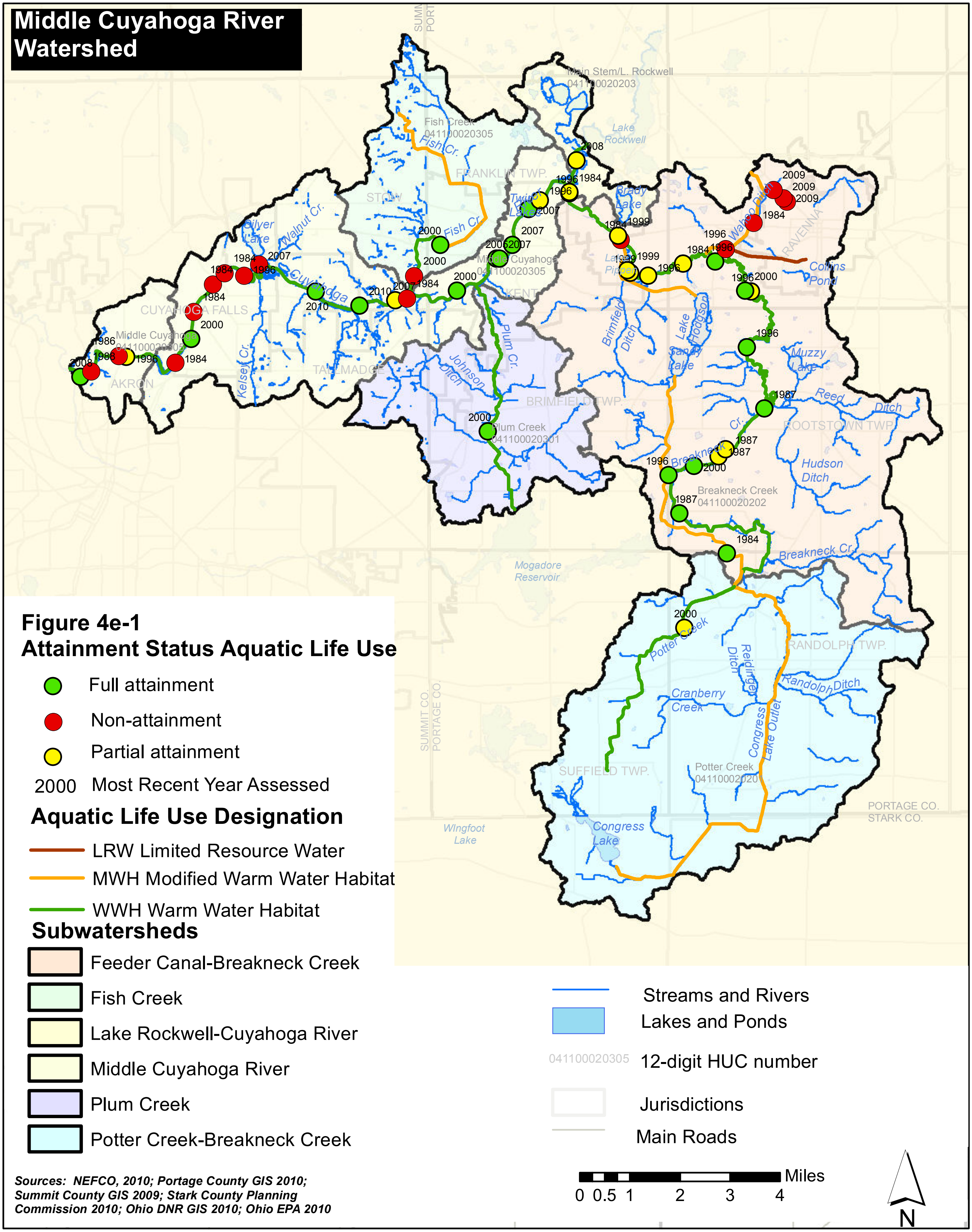
Subwatershed, HUC 04110002…, Segment, Assess Date/Report	Desig. Uses*	Location, RM (River Mile) and collection type (b = boat, w = wading)	ALU Attain/ 2010 AU score	IBI	MI wb	ICI	QHEI	Causes/Sources of Non-Attainment	Comments
Fish Creek, 0305 *EPA 2010, EPA 2000*			AU score 55						
RM 1.3-River	WWH, AWS, IWS, PCR	RM 0.1/0.4	Non	32	N/A	F*	70.5	Unknown (high) Urban runoff (high), highway maintenance, spills, natural (slight)	"Fair" ranking for fish, macroinvertebrates; habitat not limiting
- UST RM 1.3	MWH-C, AWS, IWS, PCR								Due to channelization for flood control, creek UST of RM 1.3 designated MWH-C

Abbreviations RM = River Mile mapped from confluence/mouth to headwaters UST = upstream DST = downstream

Designated Uses: ALU = Aquatic Life Use
WWH = Warm Water Habitat MWH-C= Modified Warm Water Habitat, Channel modification LRW = Limited Resource Waters
AWS = Agricultural Water Supply IWS = Industrial Water Supply PWS = public water supply
PCR = Primary Contact Recreation SCR = Secondary Contact Recreation

Biological Community Indices **EOLP Ecoregion Target Scores**:
IBI = Index of biological integrity (fish) WWH 38/40 (Wading/boat); 40 headwaters MWH C - 24 (headwaters, wading, boat)
MIwb = Modified Index of Well-being (fish) WWH 7.9/8.7 (Wading/boat) MWH C --
ICI = Invertebrate community index WWH 34 MWH C - 22 (fair)
QHEI = Qualitative Habitat Evaluation Index WWH 60 MWH C --
QHEI scores: Excellent 70-100 Good 55-69 Fair 43-54 Poor 30-42 Very poor <30

Sources:
1) Ohio EPA 2010 Integrated Report
Ohio EPA 2009. Biological and Water Quality Assessment of **Wahoo Ditch** (Former White Rubber Property), 2009. Portage County, Ohio
Ohio EPA 2008. **Cuyahoga River** Aquatic Life Use Attainment Following the **Kent and Munroe Falls** Dam Modifications. Portage and Summit Counties, Ohio
Ohio EPA 2000. Total Maximum Daily Load Middle Cuyahoga River.
Ohio EPA 2000a 305(b) Report Appendix D1 Rivers and Streams. Reporting cycle 1998, data generally collected 1996.
Ohio EPA 1997. 1997 TSD - Biological and Water Quality Study of the **Cuyahoga River and Selected Tributaries**. Geauga, Portage, Summit and Cuyahoga Counties, Ohio


Middle Cuyahoga River Watershed
Figure 4e-1
Attainment Status Aquatic Life Use
Full attainment
Non-attainment
Partial attainment
2000 Most Recent Year Assessed
Aquatic Life Use Designation
LRW Limited Resource Water
MWH Modified Warm Water Habitat
WWH Warm Water Habitat
Subwatersheds
Feeder Canal-Breakneck Creek
Fish Creek
Lake Rockwell-Cuyahoga River
Middle Cuyahoga River
Plum Creek
Potter Creek-Breakneck Creek
Streams and Rivers
Lakes and Ponds
041100020305 12-digit HUC number
Jurisdictions
Main Roads
Miles
0 0.5 1 2 3 4
N
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; Ohio EPA 2010
Main Stem/L. Rockwell
041100020203
Fish Creek
041100020305
Middle Cuyahoga
041100020305
Plum Creek
041100020301
Breakneck Creek
041100020202
Potter Creek
041100020201
FRANKLIN TWP.
STOW
CUYAHOGA FALLS
AKRON
TALLMADGE
KENT
BRIMFIELD TWP.
ROOTSTOWN TWP.
RAVENNA
RANDOLPH TWP.
SUFFIELD TWP.
SUMMIT CO.
PORTAGE CO.
STARK CO.
Lake Rockwell
Brady Lake
Silver Lake
Twin Lakes
Lake Pippen
Collins Pond
Lake Hodgson
Sandy Lake
Muzzy Lake
Mogadore Reservoir
Wingfoot Lake
Congress Lake
Fish Cr.
Walnut Cr.
Cuyahoga
Kelsey Cr.
Plum Cr.
Johnson Ditch
Brimfield Ditch
Walnut Ditch
Breakneck Cr.
Reed Ditch
Hudson Ditch
Potter Creek
Cranberry Creek
Reidinger Ditch
Randolph Ditch
Congress Lake Outlet

Main Stem

Middle Cuyahoga River TMDL and Follow-up – Breakneck Creek to Water Works Park

The Middle Cuyahoga River TMDL covers a portion of the river extending roughly from Breakneck Creek to Water Works Park.

The 2000 TMDL reported that this portion of the river was in non-attainment of WWH standards: QHEI scores ranged from 46 to 70 between Lake Rockwell and the Ohio Edison dam pool, and in almost all cases, were adversely affected by the presence of silt and embeddedness, and lack of sinuosity and fast currents.

- The IBI scores were depressed from Lake Rockwell due to the impoundments and low dissolved oxygen, showing a decrease in round-bodied suckers and lithophils and an increase in tolerant fish. Tolerant species were most abundant downstream of Fuller Park in Kent, possibly reflecting the influence of Breakneck Creek nutrients.
- The MIwb, an indicator of biomass, also declined downstream of Lake Rockwell.
- The macroinvertebrate scores, which depend less on habitat, met the WWH criteria except downstream of Lake Rockwell.

The 2000 TMDL found that nutrient enrichment, low dissolved oxygen, and poor habitat caused the river to be in non-attainment, all of which stemmed from the hydromodification related to the dam pools. The TMDL recommended restoration of flow at the dams at Kent and Munroe Falls, increased flow from Lake Rockwell, and improvements or monitoring at various water and wastewater treatment plants. The dams at Kent and Munroe Falls have been altered or removed, the City of Akron has been required to increase its daily release from Lake Rockwell, and wastewater treatment plans were upgraded.

The Ohio EPA has conducted monitoring following the flow restoration, publishing results in its 2007 report, Cuyahoga River Aquatic Life Use Attainment Following the Kent and Munroe Falls Dam Modifications. In the years following dam removal/alteration, the habitat and biota between the Munroe Falls Dam site and Lake Rockwell recovered to full attainment status. By changing the substrate composition, stream morphology, and hydrology, habitat improved and effects of nutrient enrichment declined. The 2007 assessment reported QHEI scores throughout the reach ranging from 58 downstream of the Munroe Falls dam site to 79.5, well above the level needed for WWH biological communities. By 2010, fish populations had reached full attainment throughout the dam pools.

The QHEI for the former dam pools indicated the following improvements to habitat:

- Substrate upstream of the former Munroe Falls Dam is predominantly cobble, bedrock, boulders, and gravel
- Improved riparian zone – newly formed in response to the lowered water level
- Positive channel and riparian features fully developed or recovering - channel form, riffle-run-pool sequences. While the riparian zone was vegetated, riparian cover was sparse in places due to the early stage of bank recovery and lack of trees.
- In-stream cover – the river bottom is predominantly cobble. In-stream cover was somewhat limited, as the riparian trees had grown and fallen along the edge of the former dam pool. The riparian zone of the downstream portion of the former Munroe Falls dam pool has little tree cover due to the wide band of dam-pool sediment along the margin.

Since 2007, observation indicates that additional bedrock and cobble/gravel substrate has been exposed, as sand has been transported out of the reach. In-stream cover is increasing as trees have fallen into the river and been lodged along the margins or carried downstream.

Cuyahoga River below Water Works Park/Munroe Falls Dam (Upper reaches of Lower Cuyahoga TMDL (RM 48.6 to 42.6)

The Lower Cuyahoga River TMDL covers the area between Water Works Park and the confluence with the Little Cuyahoga River. The 1999 TSD/2003 TMDL noted that in much of the Lower Cuyahoga, physical habitat attributes are generally high quality and include wooded riparian corridors, coarse substrates, and natural channel. Some areas of the corridor are urbanized, with altered channels and riparian corridors, and impacts to aquatic life. The QHEI score in the free-flowing portion of the Gorge upstream of the Ohio Edison dam and in the free-flowing portion downstream of the dam ranged from 67 to 82, and biological communities met WWH criteria but upstream (dam pools) the scores ranged from 46.5 to 56, reflecting the negative habitat features noted above (silt cover, embeddedness, lack of sinuosity).

The site at Water Works Park is downstream of the Munroe Falls and Kent dam pools and was assessed during the 2007 study. The post-dam removal QHEI score (58) at RM 48.6 in Water Works Park, downstream of the Munroe Falls Dam site, had not significantly changed from before the dam removal. Sand from the former dam pools has collected at the quiet waters in the upper portions of the Cuyahoga Falls dam pools, but it has not affected the QHEI score.

The 2003 Lower Cuyahoga TMDL noted that non-attainment in the Lower Cuyahoga was related to a shift in biological communities from sensitive species, top carnivores, and benthic insectivores (e.g., darters, insectivorous minnows, redhorse, and esocids) to tolerant species, generalists, and detritivores (e.g., carp, creek chub, bluntnose minnow, white sucker, and green sunfish). The 2000 bioassessment indicates low biomass and high occurrence of DELT anomalies, evidence of nutrient enrichment. In 2007, fish samples at RM 48.7 were not significantly different from pre-dam removal conditions, ranked “poor,” and were in non-attainment of state standards. The IBI did not change significantly from pre-removal (26 in 1996 to 23 in 2007), but the MiWB declined (7.1 to 6.4), possibly due to the migration downstream of carp from the former dam pools. Predominant species were tolerant species and omnivores: carp, bluegill, northern hog-sucker, bluegill, small-mouth bass, and white sucker.

The 2003 TMDL states that in the section of the Cuyahoga River between Lake Rockwell and the Little Cuyahoga River, primary causes of impairment were organic enrichment, low dissolved oxygen, flow and habitat alteration due to impoundments and reservoir releases. The portion immediately downstream of Water Works Park (mile 48.6) was in non-attainment due to nutrient enrichment and hydromodification.

Since habitat conditions and biological communities have not improved significantly since the initial work, the remaining dam pools can still be considered to be in non-attainment due to poor habitat and nutrient enrichment resulting from the impoundment by the dams.

Removing the Munroe Falls dam caused downstream migration of sediment as flow increased, and the sediment has been moving in a relatively cohesive lens downstream to the next dam pool in the series in Cuyahoga Falls. However, two low-head dams (less than 12 feet high) are scheduled to be removed in Cuyahoga Falls in 2012, and studies are under way to analyze the feasibility of removing the 57-foot tall Ohio Edison dam. Restoration of unimpeded flow would likely address the remaining water quality impairments along the main stem. Sediment that has accumulated in the uppermost remaining dam pool will likely be transported down to the Ohio Edison dam. The sediment behind the Ohio Edison dam would be removed and disposed in a suitable location prior to dam removal.

Tributaries

Biological monitoring has been conducted along the tributaries to a smaller degree than the Cuyahoga River. Data from Ohio EPA reports is supplemented with qualitative observations, which are also discussed further in Sections 4d-2 and 5a.

Kelsey Creek

Kelsey Creek in Kennedy Park was assessed in 2012 in response to incising related to urban runoff and removal of a low-head dam. The QHEI was 53.5. Modified influences included embeddedness, silt substrate, eroding banks, lack of cover, lack of riparian zone, lack of floodplain access. The assessment noted that many positive features still remain at the location, including riffles and pools, areas of gravel substrate. The assessment also noted that while the creek had not eroded to an irrecoverable state, if vertical erosion continued, the creek likely would degrade past the point of recovery.

Observation suggests that where the creek flows through wooded riparian areas, the substrate is less silty. Upstream of Kennedy Park, Kelsey Creek flows through the wooded Galt Park, the City of Cuyahoga Falls Brookledge golf course, a wooded riparian buffer in a subdivision, and an altered wetland at its headwaters. The creek and buffer area in Galt Park appears to have been affected by excessive runoff from development, with areas of heavily eroded banks, but appears to be recovering and has a gravelly substrate, with pools that hold water during summer dry months interspersed along an ephemeral gravelly stream bed and a wooded riparian buffer. In the riparian area within the residential subdivision, the substrate has a greater proportion of fine-grained particles, but this is near the headwaters, a low-gradient wetland area so level that the watershed divide is indistinct. Primary headwater tributaries of Kelsey Creek largely flow as drainageways through a developed landscape and are often hardened, lacking any habitat characteristics. The main stem of Kelsey Creek begins in a disturbed wetland dominated by *Phragmites*, that appears to be affected by urban runoff from nearby development. The creek appears to cross the watershed divide in the wetland, with one portion flowing north to the Middle Cuyahoga River and another flowing south to the West Branch of the Little Cuyahoga River.

Walnut Creek

Ohio EPA has not formally assessed this creek. The uppermost headwaters of Walnut Creek are largely urban drainageways. The creek flows through two parks in Stow. In both cases, the creek exhibits many positive characteristics, including heavily wooded riparian corridor, gravel or bedrock substrate. However, in both cases, the creek also shows signs of excessive loading, with eroding banks, likely a combination of steep gradient and heavily developed landscape. In Adell Durbin Park, severe erosion occurred on the hillside adjacent to Route 91. Near the confluence with the Cuyahoga River, this creek was confined in between sheet metal walls to stabilize the banks within a development that occurred on a wetland/floodplain adjacent to the creek.

Other Mainstem Tributaries

The other tributaries entering the river in the Main Stem subwatershed are headwater streams smaller than Kelsey and Walnut Creeks. Many are incising, likely a result of runoff from the heavily urbanized landscape and steep slopes. They exhibit lack of floodplain access, lack of sinuosity, rapidly eroding banks, and minimal riparian vegetation. The exception is the stream within the Munroe Falls MetroPark. MetroParks staff note that they have assessed this stream and it attains the QHEI criterion. The stream is controlled by a series of impoundments, but the portion within the park exhibits broad, vegetated riparian zone, gravel substrate, floodplain access, sinuosity, riffles and pools, and a wooded riparian buffer.

Fish Creek

The portion of Fish Creek upstream of River Mile (RM) 1.3 was re-designated MWH-C (channelized) in the early 1990s, reflecting the channelized nature of much of the creek. This portion of the creek has been in attainment of MWH-C water quality standards. The portion downstream of Spaulding Road exhibits riffles and some sinuosity within the channelized area. Upstream, the substrate of the channel appears to be silty. From the Portage County line and downstream, the creek lacks floodplain access, flowing through channelized wetlands. The primary headwaters of the creek largely flow through developed areas and exhibit varying degrees of alteration. Some flow through shaded riparian buffers; some have been protected with fringing wetlands; some flow unprotected with banks and riparian areas vegetated in sod, some are simply urban drainageways, as shown in section 4-d, Channel Conditions and Altered Riparian Zone. Many of the primary headwaters are much more steeply sloping than the main channel.

The lower 1.3 miles of the creek, still designated WWH, was not in attainment during bioassessments conducted in the mid-1990s. Biological and habitat quality were not severely degraded (IBI score 26; QHEI 70.5), but fish population data suggested stressed communities. The TMDL suggested that contributing factors included the channelization of much of the upper reaches of Fish Creek, runoff from recent construction, urban development, and agriculture. Both IBI and QHEI scores declined between 1991 and 2000, a period of rapid development in the Fish Creek subwatershed. It is likely that this portion of the creek has been degraded by upstream influences in the developed – and highly altered – portion of the watershed in Summit County and the ditched creek in Portage County. With such limited watershed functions, the high degree of imperviousness, and the non-point source pollution coming from the built watershed, this stream is overloaded with contaminants and water, and has very limited ability to mitigate the effects through assimilation, filtering, uptake, flood storage, etc.

Another factor may have an effect on the lowermost section of the channel. When the most recent bioassessment was conducted, the main stem of the Cuyahoga River was still a dam pool at a higher elevation. The water level has since been lowered. Ohio EPA staff have speculated that perhaps lowering the base level of Fish Creek (at the river) has increased the velocity in the undisturbed section enough to improve water quality attainment. It is important to re-assess the lower portion of Fish Creek to determine if the conditions have changed significantly.

Plum Creek

Plum Creek was assessed at two locations in 2000, 3 miles upstream of the confluence with the river and downstream of a small low-head dam, both of which were in full attainment, with QHEI scores of 68.5 and 62.5, respectively. Because the sampling sites are within wooded, relatively undisturbed corridors, they are likely to continue attaining the habitat criteria. However, the area has undergone substantial development in the ensuing years, and it would be valuable to re-assess periodically to determine if the changing watershed is affecting water quality. A low-head dam immediately upstream of Cherry St. was removed in 2010, restoring flow, and a portion of the creek within Plum Creek Park upstream of the dam was restored to re-establish sinuosity, floodplain access, and in-stream cover (boulders). This portion of Plum Creek is no longer a stagnant dam pool but exhibits meanders, riffles, pools, and appears to be developing a gravel substrate.

As described further in Section 4d, the lower 4-5 miles of the creek remains largely intact, flanked by extensive wetlands and floodplains, which likely contribute to the high quality of the stream. Approximately 12 miles of the upper reaches of Plum Creek have been channelized or modified to provide drainage in developed or agricultural areas and exhibit modified characteristics (lack of riparian vegetation, lack of floodplain access, eroding banks, embeddedness, lack of sinuosity). Portions of this modified landscape have been either improved (oversize stormwater basin near Munroe Rd. in Tallmadge replacing a ditch) or left undisturbed (JayCee Park on Howe Ave. in Tallmadge), improving but not entirely restoring the habitat characteristics. Portions of the creek are rapidly eroding and lack riparian vegetation in agricultural areas or golf courses. This subwatershed experienced rapid development between 2000 and 2007, the beginning of a multi-year economic slowdown. Once development begins again, it is likely that this area will again be the focus of growth. It is important to continue monitoring this creek and enforcing and improving upon the use of vegetated setbacks to protect the intact portion of the creek.

Breakneck Creek

Breakneck Creek is described as a low-gradient swamp creek with channel modification in several areas. The QHEI scores are affected by substrate and silt-free substrate categories, reflecting a relatively low velocity, and occasionally channelized sections. However, the 1997 TSD describes the biological communities between RM 5 and 15 as good to exceptional quality in full attainment of WWH criteria. This portion of the creek has abundant positive habitat characteristics, including instream cover from the largely intact wooded riparian corridor, submerged aquatic vegetation, floodplain access and deep pools.

Downstream of Summit Road, portions of the creek are channelized, and biological communities are influenced by urban development and wastewater treatment plants.

During the 1980s, macroinvertebrate sampling exceeded the WWH biocriterion from upstream to downstream of the wastewater treatment plants, and the fish community and habitat provided an excellent example of a swamp stream, with submerged aquatic vegetation, northern pike, darters, and horneyhead chubs. Between the 1980s and 1996, the fish indices downstream from the Franklin Hills wastewater treatment plant declined, indicating in-stream toxicity. During subsequent sampling in 1999, following reductions in bypasses at the Ravenna WWTP, IBI scores in the lower reaches of the creek met or were within non-significant departure of the EOLP criteria, ranging from 40 to 42. However, none of the downstream sites met MIwb criteria (ranging from 6.3-7.2, compared to the biocriterion of 7.9), indicating probable impacts from nutrient enrichment. The lowest dissolved oxygen concentration occurred just downstream from the Franklin Hills WWTP, at the same location of the lowest-scoring biological indicators. An increase in tolerant fish at RM 3.1 compared to RM 5.2 indicated impairments were related to the Franklin Hills and Ravenna wastewater treatment plants. The 2000 TMDL notes that fish communities in the Cuyahoga River downstream of Breakneck Creek declined, suggesting effects of nutrient enrichment from Breakneck Creek.

According to the 2007 EPA monitoring report on the Middle Cuyahoga River, upgrades have occurred at both wastewater treatment plants. It is important to re-assess the lower portion of Breakneck Creek to determine if the upgrades improved water quality or if the altered watershed has affected water quality.

As described further in Section 4d-2 and 5a, several tributaries to Breakneck Creek and the uppermost reaches (above the confluence with Congress Lake Outlet/Potter Creek) are channelized and are influenced by factors such as:

- eroding banks from runoff or agricultural activity, including unrestricted livestock access
- urban runoff
- lack of vegetated riparian buffers, floodplain access, and sinuosity,
- high degree of embeddedness.

In spite of habitat impairments along the channelized ditches and headwater streams, it appears that the extensive flanking wetlands and floodplains of the middle portion of Breakneck Creek buffer the impacts from the upstream tributaries.

Wahoo Ditch

Wahoo Ditch has been in non-attainment of modified WWH standards for channels from the first studies in the 1980s to 2009, when it was assessed as part of a Voluntary Action Plan for remediation at the former White Rubber Corp. Factors in non-attainment included of habitat alterations, organic enrichment, unknown contaminants, urban runoff, channelization, sediment PAH, legacy contaminants, its severe ditchlike condition, channelization, and a major municipal point source (2000), Wahoo Ditch is a maintained ditch, with severely altered hydrology, flowing through a heavily urbanized and industrialized area. There is some open land alongside portions of the ditch. It may be possible to improve conditions at isolated locations in the ditch.

Wahoo Ditch was assessed for the 1997 TSD and also more recently for a Voluntary Action Plan (VAP) for a cleanup on a property along Wahoo Ditch. The 2000 TMDL indicated that macroinvertebrate communities in Wahoo Ditch, designated MWH, were very poor downstream of the Ravenna WWTP and were in non-attainment of MWH standards. The TMDL noted that toxicity effects from the WWTP effluent were probably exacerbated by the extremely severe ditch-like conditions of the channel. Nitrate, phosphorous, and ammonia concentrations in Wahoo Ditch were higher than in Breakneck Creek. The 2009 bioassessment reported that the ditch was still in non-attainment. IBI scores at three sites near the proposed VAP property ranged from 22 to 26, which marginally attained MWH criteria, except at RM 2.5, where the fish community was dominated by pollution/habitat tolerant species. ICI narrative scores were “poor,” ranging from 21-28, and habitat scores of 44.5-55, were described as fair to good for channelized conditions. See Table 4e-3. Conditions affecting the scores included embeddedness, silt substrate, channelization. All sites were severely embedded. The 2009 report identified the causes and sources of non-attainment as:

- Causes - Habitat, unknown contaminant, PAHs
- Sources - Channelization, urban runoff- discharge, legacy contaminant sediments.

Chemical analysis of the Wahoo Ditch sediments indicated that all three sampling sites had PAH compounds in the sediment that exceeded the Probable Effect Concentration (PEC) a level of concentration above which effects are likely to be observed.

Potter Creek

The 2000 TMDL noted that Potter Creek was in attainment of chemical standards, but did not fully meet WWH standards due to a poor fish community. The TMDL noted that the creek was recovering from prior channelization, with a narrow riparian corridor becoming established along portions and free-flowing conditions beginning to develop. However, the TMDL noted that the creek was still degraded by embedding silt and poor channel development. Based on field visits to road crossings and a potential restoration site, all these observations still appear to be valid: While portions of Potter Creek (especially in wooded or wetland areas) are recovering stream form and habitat characteristics, many portions of the creek are still embedded with silt and exhibit poor channel formation, lacking many important stream channel elements and functions.

Recent observations indicate that the riparian corridor continues to develop at the sampling location (Trares Rd.). Upstream of the sampling site, a portion of Potter Creek was evaluated for a potential stream restoration/improvement project within an agricultural field near Conley Road. Within the agricultural field, Potter Creek is channelized and severely embedded. Upstream of the agricultural field, the creek habitat is clearly recovering as it flows undisturbed through a wooded reach and exhibits gravel substrate, and shallow pools and riffles. Observed conditions along the length of Potter Creek vary, including severely channelized and embedded sections, reaches that are recovering in woods or adjacent to livestock yards, a narrow grassed channel in a residential area, and an apparently intact section within a wetland complex at the lower end. Channel conditions are discussed further in Section 4d-2.

Bacteria

Bacteria

Water quality standards include bacteria limits in recreational waters. The 2003 Lower Cuyahoga River TMDL listed bacteria exceedences as one of the quantifiable causes of impairment of the Lower Cuyahoga River. Bacteria level exceedences listed in the TMDLs and subsequent monitoring are shown in Table 4e-4. August 10, 2000, was a period of relatively high flow (500 cfs, falling from 900 cfs three days earlier).

Table 4e-4 Bacteria Exceedences

Location	Date	Fecal coliform/e. coli mpn*
Cuyahoga River		
Cuyahoga St., RM 42.6	8/10/2000	5,300/3,600
Cuyahoga St., RM 42.6	7/14/2008	--/1,200
Broad Blvd (RM 46.25)	8/10/2000 8/3/2000	2000/140 1,000/630
Water Works Park (RM 48.38)	8/10/2000	5,200/2,600
Tributaries		
Fish Creek at Spaulding Dr.	8/3/2000	1,100/1,400
Fish Creek at N. River Rd. RM 0.4	8/3/2000	1,000/580
Plum Creek at Cherry	8/3/2000	1,700/530

* *State Rec. Waters e. coli criteria: Cat. A - 298 Cat. B - 523*

Bacteria exceedences along the Cuyahoga River corresponded to higher flows in the river.

Beneficial Use Impairments – Area of Concern

Beneficial Use Impairments: Area of Concern (AOC)

The Cuyahoga River Area of Concern extends to the area of the Gorge in Cuyahoga Falls. The AOC had originally been designated as far upstream as the Ohio Edison Dam but has recently been extended into the Gorge area in Cuyahoga Falls to include sediment in the dam pool upstream of the Ohio Edison dam.

Beneficial use impairments identified in the Remedial Action Plan include:
- Cultural eutrophication (nutrients)
- Toxic substances
- Bacterial contamination
- Habitat modification
- Sedimentation

Sources include:
- Municipal and industrial discharge
- Bank erosion
- Commercial/residential development
- Atmospheric deposition
- Hazardous waste disposal sites
- Urban stormwater runoff
- Combined sewer overflows
- Wastewater treatment plant bypasses

Chemistry: Nutrients - Background

Nutrient enrichment in the Cuyahoga River has been a concern in all recent restoration efforts, and nutrient enrichment has again become a concern in Lake Erie. The 2000 Middle Cuyahoga TMDL focused on dissolved oxygen levels and nutrient enrichment. Dam removal/modification and upgrades to wastewater treatment plants reduced but did not entirely eliminate the enrichment. The Lower Cuyahoga River TMDL lists nutrients as a major cause of non-attainment and urban runoff as a major source. Within the Cuyahoga River AOC, cultural eutrophication was listed as a cause of impairment of beneficial use attainment.

Key nutrients in the Cuyahoga River are phosphorous and nitrogen. Phosphorous is the limiting nutrient in the aquatic system of the Cuyahoga River and Lake Erie downstream, meaning that as levels of phosphorous increase, algal growth will likely increase.

In its 1999 technical bulletin, Ohio EPA assessed the effects of nutrients on quality of habitats and eutrophication throughout the state. Waters with greater amounts of nutrients relative to the ecoregion median were considered enriched in nutrients. Ohio EPA is using the 75th percentile value of nutrients as a statewide target for nutrients. (See Table 4e-5.)

Table 4e-5
Nutrient targets and median values for EOLP communities in attainment

	Total P (mg/l)		**Nitrate + Nitrite (mg/l)**	
	EOLP Median/Target	Statewide Target *WWH MWH*	EOLP Median/Target	Statewide Target *WWH MWH*
Headwaters (drainage area <20 sq. mi.)	0.05	0.08 0.34	1.0	1.0 1.0
Wadable streams (drainage area (20-200 sq. mi.)	0.07	0.01 0.28	1.05	1.0 1.6
Small rivers (drainage area 200-1,000 sq. mi.)	0.12	0.17 0.25	1.42	1.5 2.2

Total Phosphorous includes dissolved phosphorous (DRP/SRP – dissolved or soluble reactive phosphorous, phosphate) and orthophosphorous. Orthophosphorous, which sorbs to fine sediment, increases with storm water runoff and accumulates at the bottom of lakes and dam pools. DRP is more readily available for biological uptake. It is closely associated with animal waste products and is influenced by levels in treated wastewater and agricultural runoff. Reducing the adverse effects of nutrient enrichment requires reducing phosphorous from both sources.

Several nitrogen compounds are available for and part of algal growth in fresh waters. Nitrate and nitrite are associated with animal waste and may be found in wastewater treatment effluent.

Findings: Nutrients in the Cuyahoga River and Tributaries

Assessments of the Cuyahoga River have included a multi-faceted assessment of indicators, which suggest that the Cuyahoga River is somewhat enriched in nutrients. The following are discussion points raised in the 1999 TSD, 2000 TMDL, 2003 TMDL, and 2007 Bioassessment following dam removal/alteration:

- Levels of total and dissolved phosphorous in the river are occasionally higher than the state median values for the ecoregion (0.12 mg/l), ranging from <0.05 mg/l to 0.46 mg/l. (See Table 4e-6). The higher values on July 11-12, 2007, shown on Table 4e-6, occurred during or after a rain event, suggesting that runoff is contributing phosphorous to some degree.

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous			Nitrogen					
			TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Cuyahoga River Main Stem											
State Criteria				0.17			1.5			Class A rec.	298
EOLP Median					0.12			1			
Cuyahoga Street RM 42.6	7/19/00	300, falling from 1,000 cfs on 7/14	0.09	FALSE	FALSE	1.14	FALSE	**TRUE**	11	210	FALSE
	7/25/00	120, falling	0.06	FALSE	FALSE	1.16	FALSE	**TRUE**	<5	64	FALSE
	8/3/00	165, falling	0.06	FALSE	FALSE	1.35	FALSE	**TRUE**	<5	220	FALSE
	8/10/00	550, falling from 900 on 8/7; turbid, high flow								3600	**TRUE**
	9/14/00	130, level	0.1	FALSE	FALSE	1.97	**TRUE**	**TRUE**	<5	69	FALSE
	7/10/01	125, falling from 180	0.075	FALSE	FALSE	1.48	FALSE	**TRUE**	<5		
	7/12/01	110, falling	0.079	FALSE	FALSE	1.36	FALSE	**TRUE**	<5		
	8/29/01	84, falling from 120	<.05	FALSE	FALSE	1.84	**TRUE**	**TRUE**	6		
	8/30/01	65	<.05	FALSE	FALSE	1.68	**TRUE**	**TRUE**	5		
	6/25/08	250 falling from 400 on 6/23	0.054	FALSE	FALSE	1.46	FALSE	**TRUE**	10		
	7/14/08	250 falling from 400 on 7/13	0.079	FALSE	FALSE	0.88	FALSE	FALSE	14	1200	**TRUE**
	7/28/08	180 falling from 220	0.08	FALSE	FALSE	1.42	FALSE	**TRUE**	6	88	FALSE
	8/4/08	100, level	0.046	FALSE	FALSE	0.82	FALSE	FALSE	<5	160	FALSE
	8/21/08	200 falling from 400 on 8/14	0.045	FALSE	FALSE	0.86	FALSE	FALSE	9	94	FALSE
DST of Gorge Dam RM 43.8	8/28/01	225, rising	0.099	FALSE	FALSE	1.9	**TRUE**	**TRUE**	<5		
	8/29/01	225, falling from 240	<.05	FALSE	FALSE	1.74	**TRUE**	**TRUE**	<5		
Edison Dam Pool (RM 45.1)	8/30/01	180, falling	0.053	FALSE	FALSE	1.79	**TRUE**	**TRUE**	5		
Oak Park Blvd (RM 47.6)	8/29/01	200, falling	0.112	FALSE	FALSE	2.02	**TRUE**	**TRUE**	7		
	8/30/01		0.055	FALSE	FALSE	1.93	**TRUE**	**TRUE**	15		
Broad Blvd (RM 46.25)	7/19/00		0.1	FALSE	FALSE	1.31	FALSE	**TRUE**	19	360	**TRUE**
	7/25/00		0.08	FALSE	FALSE	1.77	**TRUE**	**TRUE**	11	120	FALSE
	8/3/00		0.08	FALSE	FALSE	1.54	**TRUE**	**TRUE**	11	630	**TRUE**
	8/10/00		0.1	FALSE	FALSE	0.521	FALSE	FALSE	13	140	FALSE
	8/10/00		0.12	FALSE	FALSE	0.579	FALSE	FALSE	21		
	9/14/00		0.12	FALSE	FALSE	1.98	**TRUE**	**TRUE**	6	130	FALSE

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Broad Blvd (cont'd)	5/16/01	190, falling from 200	0.298	TRUE	TRUE	1.49	FALSE	TRUE	11		
	6/12/01	150, falling from 180 on 6	0.11	FALSE	FALSE	1.26	FALSE	TRUE	12		
	7/11/01		0.113	FALSE	FALSE	1.4	FALSE	TRUE	11		
	6/5/02		0.079	FALSE	FALSE	1.09	FALSE	TRUE	15		
Waterworks (RM 48.38)	7/11/07	120, peaking	0.14	FALSE	TRUE	3.02	TRUE	TRUE	105		
	7/12/07	100, falling from 120	0.146	FALSE	TRUE	2.12	TRUE	TRUE	95		
	8/27/07	500, falling from 2,000 on	0.06	FALSE	FALSE	0.88	FALSE	FALSE	11		
	9/19/07	90 and level	0.054	FALSE	FALSE	3.96	TRUE	TRUE	<5		
	9/20/07	90 and level	0.044	FALSE	FALSE	4.11	TRUE	TRUE	5		
Bike Trail Bridge (RM 49.07)	7/11/07		0.082	FALSE	FALSE	2.12	TRUE	TRUE	12		
	7/12/07		0.09	FALSE	FALSE	2.39	TRUE	TRUE	26		
	9/19/07		0.05	FALSE	FALSE	3.89	TRUE	TRUE	10		
	9/20/07		0.043	FALSE	FALSE	4.34	TRUE	TRUE	10		
Munroe Falls Dam (RM 49.9)	8/28/01		0.107	FALSE	FALSE	2.18	TRUE	TRUE	9		
	8/30/01		0.054	FALSE	FALSE	2.17	TRUE	TRUE	5		
	8/29/01		<.05	FALSE	FALSE	2.26	TRUE	TRUE	<5		
	6/29/05	135, level	0.065	FALSE	FALSE	1.68	TRUE	TRUE	<5		
	8/2/05	170, falling from 350	0.08	FALSE	FALSE	1.01	FALSE	TRUE	9		
	8/18/05	140, falling from 200	0.141	FALSE	TRUE	1.84	TRUE	TRUE	73		
	7/11/07		0.075	FALSE	FALSE	3.36	TRUE	TRUE	34		
	7/12/07		0.066	FALSE	FALSE	2.59	TRUE	TRUE	<5		
	7/12/07		0.075	FALSE	FALSE	2.82	TRUE	TRUE	7		
	7/12/07		0.072	FALSE	FALSE	3.02	TRUE	TRUE	6		
	8/27/07		0.061	FALSE	FALSE	0.92	FALSE	FALSE	11		
	9/19/07		0.062	FALSE	FALSE	4.18	TRUE	TRUE	5		
	9/20/07		0.042	FALSE	FALSE	4.34	TRUE	TRUE	6		
Munroe Falls MetroPark (RM 50.1	7/11/07		0.128	FALSE	TRUE	5.79	TRUE	TRUE	20		
	7/11/07		0.106	FALSE	FALSE	3.85	TRUE	TRUE	65		
	7/12/07		0.114	FALSE	FALSE	3.26	TRUE	TRUE	51		
	7/12/07		0.15	FALSE	TRUE	2.74	TRUE	TRUE	5		
	9/19/07		0.078	FALSE	FALSE	4.27	TRUE	TRUE	5		
	9/20/07		0.079	FALSE	FALSE	4.59	TRUE	TRUE	6		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Downstream Fish Creek (RM 51.64)											
	7/11/07		0.075	FALSE	FALSE	2.6	TRUE	TRUE	5		
	8/28/07		0.067	FALSE	FALSE	1.15	FALSE	TRUE	11		
	9/19/11		0.08	FALSE	FALSE	4.29	TRUE	TRUE	5		
	9/20/11		0.088	FALSE	FALSE	4.39	TRUE	TRUE	<5		
Middlebury (RM 52.63)											
	8/29/01		0.208	TRUE	TRUE	3.83	TRUE	TRUE	87		
	8/30/01		0.159	FALSE	TRUE	3.47	TRUE	TRUE	<5		
	7/11/07		0.102	FALSE	FALSE	3.37	TRUE	TRUE	20		
	7/12/07		0.078	FALSE	FALSE	3.17	TRUE	TRUE	5		
	9/19/07		0.082	FALSE	FALSE	6.01	TRUE	TRUE	<5		
	9/20/11		0.078	FALSE	FALSE	5.12	TRUE	TRUE	<5		
0.8 mi UST Middlebury RM 53.4	7/11/07		0.072	FALSE	FALSE	3.94	TRUE	TRUE	<5		
	7/12/07		0.089	FALSE	FALSE	4.55	TRUE	TRUE	7		
	7/12/07		0.081	FALSE	FALSE	3.58	TRUE	TRUE	10		
	8/28/07		0.067	FALSE	FALSE	1	FALSE	FALSE	11		
	8/28/07		0.064	FALSE	FALSE	1.05	FALSE	TRUE	10		
	9/19/07		0.091	FALSE	FALSE	5.13	TRUE	TRUE	<5		
	9/20/07		0.075	FALSE	FALSE	5.81	TRUE	TRUE	<5		
Fuller Park UST Kent WWTP RM	7/11/07		0.129	FALSE	TRUE	1.82	TRUE	TRUE	61		
	7/12/07		0.074	FALSE	FALSE	2.64	TRUE	TRUE	8		
	7/12/07		0.131	FALSE	TRUE	2.94	TRUE	TRUE	54		
	9/19/07		0.07	FALSE	FALSE	2.96	TRUE	TRUE	7		
	9/20/07		0.053	FALSE	FALSE	2.95	TRUE	TRUE	10		
Crain Ave. (RM 55.2)	8/13/98		0.1	FALSE	FALSE	1.22	FALSE	TRUE	13		
	6/29/05		0.088	FALSE	FALSE	1.58	TRUE	TRUE	7		
	8/2/05		0.07	FALSE	FALSE	1.17	FALSE	TRUE	10		
	8/18/05		0.087	FALSE	FALSE	1.38	FALSE	TRUE	9		
	7/11/07		0.09	FALSE	FALSE	2.54	TRUE	TRUE	14		
	7/12/07		0.152	FALSE	TRUE	2.78	TRUE	TRUE	72		
	9/19/07		0.074	FALSE	FALSE	2.88	TRUE	TRUE	<5		
	9/20/07		0.062	FALSE	FALSE	2.66	TRUE	TRUE	<5		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous			Nitrogen					
			TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Standing Rock (RM 55.8)	8/13/98		0.14	FALSE	TRUE	1.22	FALSE	TRUE	14		
	6/29/05		0.081	FALSE	FALSE	3.11	TRUE	TRUE	5		
	8/2/05		0.052	FALSE	FALSE	2.37	TRUE	TRUE	9		
	8/18/11		0.083	FALSE	FALSE	2.03	TRUE	TRUE	12		
Riverbend (RM 56.2)	8/13/98		0.12	FALSE	FALSE	1.14	FALSE	TRUE	18		
	7/11/07		0.373	TRUE	TRUE	2.21	TRUE	TRUE	300		
	7/12/07		0.299	TRUE	TRUE	2.8	TRUE	TRUE	211		
	7/19/07		0.044	FALSE	FALSE	39.8	TRUE	TRUE	<5		
	9/20/07		0.075	FALSE	FALSE	3.03	TRUE	TRUE	9		
UST Breakneck Cr. (RM 56.83)	8/13/98		0.14	FALSE	TRUE	0.21	FALSE	FALSE	8		
	7/11/07		0.061	FALSE	FALSE	0.19	FALSE	FALSE	0.26		
	7/11/07		0.034	FALSE	FALSE	0.18	FALSE	FALSE	<5		
	7/12/07		0.081	FALSE	FALSE	0.14	FALSE	FALSE	<5		
	8/27/07		0.03	FALSE	FALSE	<.01	FALSE	FALSE	9		
	9/19/07		0.015	FALSE	FALSE	0.18	FALSE	FALSE	5		
	9/20/07		0.023	FALSE	FALSE	0.13	FALSE	FALSE	<5		
DST Lake Rockwell (RM 57.67)	8/13/98		0.18	TRUE	TRUE	0.33	FALSE	FALSE	10		
	8/28/01		0.059	FALSE	FALSE	0.13	FALSE	FALSE	<5		
	8/30/01		<.05	FALSE	FALSE	0.15	FALSE	FALSE	7		
	8/30/01		0.066	FALSE	FALSE	0.13	FALSE	FALSE	7		
	7/10/02		0.11	FALSE	FALSE	0.13	FALSE	FALSE	7		
	6/25/08		0.052	FALSE	FALSE	<.1	FALSE	FALSE	9	<25	
	7/14/08		0.05	FALSE	FALSE	0.13	FALSE	FALSE	9		16
	7/28/08		0.064	FALSE	FALSE	0.15	FALSE	FALSE	9		15
	8/4/08		0.049	FALSE	FALSE	0.27	FALSE	FALSE	8		15
	8/21/08		0.071	FALSE	FALSE	<.1	FALSE	FALSE	9		3
	7/11/07		0.464	TRUE	TRUE	0.34	FALSE	FALSE	20		
	7/11/07		0.046	FALSE	FALSE	0.15	FALSE	FALSE	7		
	7/11/07		0.043	FALSE	FALSE	0.17	FALSE	FALSE	7		
	7/12/07		0.047	FALSE	FALSE	0.16	FALSE	FALSE	6		
	9/19/07		0.027	FALSE	FALSE	0.13	FALSE	FALSE	9		
	9/20/07		0.045	FALSE	FALSE	0.1	FALSE	FALSE	16		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Fish Creek											
Statewide Criteria - MWH				0.34			1			Cat. B. rec.	523
EOLP Median					0.19			0.42			
Spaulding	7/19/00		0.05	FALSE	FALSE	0.125	FALSE	FALSE	7	590	**TRUE**
	8/3/00					0.116	FALSE	FALSE	7	1400	**TRUE**
	9/14/00		<.05			0.1	FALSE	FALSE	8	240	FALSE
North River Rd.											
Statewide Criteria - WWH				0.08			1				
EOLP Median					0.05			0.42			
	7/19/00		0.07	FALSE	**TRUE**	0.297	FALSE	FALSE	<5		
	8/3/00		0.06	FALSE	**TRUE**	0.22	FALSE	FALSE	<5		
	9/14/00		<.05	FALSE	FALSE	0.191	FALSE	FALSE	<5		
	8/29/01		1.08	**TRUE**	**TRUE**	0.34	FALSE	FALSE	<5		
	8/30/01		<.05	FALSE	FALSE	0.3	FALSE	FALSE	10		
	7/11/07		0.054	FALSE	**TRUE**	0.48	**TRUE**	**TRUE**	11		
	7/11/07		0.05	FALSE	FALSE	0.46	**TRUE**	**TRUE**	11		
	7/12/07		0.024	FALSE	FALSE	0.21	FALSE	FALSE	<5		
	7/12/07		0.022	FALSE	FALSE	0.2	FALSE	FALSE	<5		
	8/27/07		0.052	FALSE	**TRUE**	0.29	FALSE	FALSE	<5		
	9/19/07		0.22	**TRUE**	**TRUE**	0.34	FALSE	FALSE	<5		
	9/20/07					0.14	FALSE	FALSE	<5		

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous TP (mg/l)	Phosphorous Exceed State	Phosphorous Exceed EOLP Median	Nitrogen Nitrate + Nitrite (mg/l)	Nitrogen Exceed State	Nitrogen Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Plum Creek											
Tallmadge Rd.	7/19/00		0.05	FALSE	FALSE	0.299	FALSE	FALSE	5	260	FALSE
	8/3/00		<.05	FALSE	FALSE	0.283	FALSE	FALSE	<5	100	FALSE
	9/14/00		0.05	FALSE	FALSE	0.23	FALSE	FALSE	<5	54	FALSE
Cherry	7/19/00		0.08	FALSE	**TRUE**	0.19	FALSE	FALSE	31	410	FALSE
	8/3/00		0.05	FALSE	FALSE	0.106	FALSE	FALSE	15	360	FALSE
	9/14/00		0.06	FALSE	**TRUE**	<.1	FALSE	FALSE	21	130	FALSE
	8/29/01		<.05	FALSE	FALSE	<.1	FALSE	FALSE	11		
	8/30/01		<.05	FALSE	FALSE	<.1	FALSE	FALSE	23		
	7/11/07		0.042	FALSE	FALSE	0.29	FALSE	FALSE	20		
	7/12/07		0.04	FALSE	FALSE	0.2	FALSE	FALSE	24		
	7/12/07		0.053	FALSE	**TRUE**	0.2	FALSE	FALSE	40		
	8/27/07		0.04	FALSE	FALSE	0.12	FALSE	FALSE	8		
	9/19/07		0.03	FALSE	FALSE	0.21	FALSE	FALSE	6		
	9/20/07		0.027	FALSE	FALSE	<01	FALSE	FALSE	6		
Breakneck Cr.											
Statewide Criteria				0.1			1				
EOLP Median WWH					0.07			0.43			
Mouth	8/13/98		0.19	**TRUE**	**TRUE**	1.28	**TRUE**	**TRUE**	27		
	7/11/07		0.18	**TRUE**	**TRUE**	7.43	**TRUE**	**TRUE**	35		
	7/12/07		0.17	**TRUE**	**TRUE**	4.57	**TRUE**	**TRUE**	47		
	8/27/07		0.08	FALSE	**TRUE**	0.68	FALSE	**TRUE**	11		
	9/19/07		0.109	**TRUE**	**TRUE**	5.72	**TRUE**	**TRUE**	<5		
	9/20/07		0.111	**TRUE**	**TRUE**	5.26	**TRUE**	**TRUE**	<5		
Summit Road											
	7/19/00		0.08	FALSE	**TRUE**	0.413	FALSE	FALSE	<5	340	FALSE
	7/25/00		0.07	FALSE	FALSE	0.638	FALSE	**TRUE**	8	370	FALSE
	7/25/00		0.07	FALSE	FALSE	0.515	FALSE	**TRUE**	6	330	FALSE
	8/3/00		0.14	**TRUE**	**TRUE**	0.346	FALSE	FALSE	<5	180	FALSE
RM 14.6	7/19/00		0.13	**TRUE**	**TRUE**	0.379	FALSE	FALSE	24	470	FALSE
	7/25/00		0.07	FALSE	FALSE	0.537	FALSE	**TRUE**	6	220	FALSE
	7/25/00		0.065	FALSE	FALSE	0.68	FALSE	**TRUE**	5	200	FALSE
	8/3/00		0.08	FALSE	**TRUE**	0.291	FALSE	FALSE	<5	490	FALSE

Table 4e-6 Water Quality Monitoring Data - Chemistry and Bacteria

Water Course/Water Body	Date	Approx. Daily Flow (cfs) at Portage Path, stage	Phosphorous			Nitrogen					
			TP (mg/l)	Exceed State	Exceed EOLP Median	Nitrate + Nitrite (mg/l)	Exceed State	Exceed EOLP Median	TSS (mg/l)	E. Coli #/100 ml	Exceed Standard E. Coli col./100 ml
Potter Creek											
Statewide Criteria				0.08			1				
EOLP Median WWH					0.05			0.42			
Saxe Rd.											
	7/19/00		0.16	TRUE	TRUE	0.473	FALSE	TRUE	6	810	TRUE
	7/25/00		0.05	FALSE	FALSE	0.664	FALSE	TRUE	<5	270	FALSE
Feeder Canal											
Statewide Criteria											
EOLP Median MWH											
	7/25/00		0.06	FALSE	TRUE	7.32	TRUE	TRUE	<5		
	8/3/00		0.075	FALSE	TRUE	0.328	FALSE	FALSE	<5		
Congress Lake Outlet*					***note: only nitrate reported***					fecal coliform	
Statewide Criteria - MWH				*0.34*			*1*				
EOLP Median MWH					*0.19*			*0.42*			
Congress Lake	winter		0.25	FALSE	TRUE	0.55	FALSE	TRUE		20	
	spring		0.05	FALSE	FALSE	0.9	FALSE	TRUE		0	
Quail Hollow	winter		0.24	FALSE	TRUE	0.5	FALSE	TRUE		60	
	spring		0.11	FALSE	FALSE	0.7	FALSE	TRUE		1200	
Pinedale	winter		0.08	FALSE	FALSE	0.19	FALSE	FALSE		70	
	spring		0.08	FALSE	FALSE	0.6	FALSE	TRUE		100	
Alexander Rd.	winter		0.08	FALSE	FALSE	0.19	FALSE	FALSE		80	
	spring		0.07	FALSE	FALSE	1	FALSE	TRUE		20	
Waterloo Rd.	winter		0.08	FALSE	FALSE	0.18	FALSE	FALSE		300	
	spring		0.07	FALSE	FALSE	1	FALSE	TRUE		70	
Hartville Rd.	winter		0.07	FALSE	FALSE	0.14	FALSE	FALSE		200	
	spring		0.09	FALSE	FALSE	0.9	FALSE	TRUE		110	
Statewide Criteria - MWH > 20 sq. mi				0.28			1.6				
EOLP Median MWH > 20 sq. mi.					0.25			0.43			
BNC Tallmadge Rd.			0.04			0.11	FALSE	FALSE		80	
			0.08			0.7	FALSE	TRUE		40	

Source: Bonetta Guyette MS Thesis

- Nitrate+nitrite nitrogen levels vary from 0.13 mg/l upstream of Breakneck Creek to 6.01 mg/l at Middlebury, compared with the EOLP median value of 1 mg/l. High values of nitrate-nitrite are recorded during higher flows of July 11-12, 2007, as well as relatively low flows of September 19, 2007, indicating that the nitrogen is entering both from wastewater treatment plants and runoff.
- Biological communities – The 1999 TSD and 2000 TMDL reports noted higher numbers of hydra, flatworms, oligocheates, omnivores, detritivores, and tolerant species. The report notes that a low IBI score, combined with an MiWB score (biomass) similar to EOLP median values, suggests nutrient enrichment is affecting the biological communities.
- The 2007 Bioassessment noted large diurnal swings in oxygen in the Middle Cuyahoga River, by as much as five mg/l upstream of Fish Creek and 15 mg/l at Water Works Park in the 2007 study. The swings in dissolved oxygen suggest algae levels are high, producing oxygen during the day and consuming it at night.
- Low dissolved oxygen levels in the former dam pools – low levels during summer months indicate anoxic conditions due to the decay of algae. The standard for 24-hour mean dissolved oxygen is 5 mg/l, minimum 4 mg/l.
- Supersaturated oxygen levels – greater than what would occur in an unenriched environment at the same temperature – these values are often greater than 95 or 100 percent saturation, indicating daytime oxygen production by algae.

Dam pools and lakes may result in increased algal production and anoxic conditions:

- They trap sediment and the adsorbed phosphorous
- Decaying algae in the lower, unmixed portions of the stagnant pools uses up oxygen
- Without moving water and biological activity, the incoming nutrients are not assimilated and transformed.

The degree of nutrient enrichment in the former dam pools has improved considerably with dam removal. In the area of the former dam pools, the river is no longer eutrophic or anoxic and the river meets biological water quality standards. Phosphorous levels have dropped, as the river has been able to assimilate the phosphorous or transport it downstream.

The 2007 report notes that lack of tree cover along portions of the river may increase algal production.

Table 4e-6 shows water quality chemistry (phosphorous and nitrate+nitrite) and bacteria data posted on the Ohio EPA website for sites within the watershed. For each component, the table lists the EOLP target/median and the state target, and indicates whether the measurement exceeded the targets (TRUE, highlighted in bold red), or did not exceed the targets (FALSE).

In reviewing the data, these are some of the characteristics that may influence levels of nutrients:

- Wastewater treatment plants operate along the lower portion of Breakneck Creek, in Kent between Fuller Park and Middlebury, and at Fish Creek. Four CSOs (combined sewer overflows) have been documented in the Gorge section of the river in Cuyahoga Falls.
- Three dams remain along the Cuyahoga River in this watershed: two low-head dams in Cuyahoga Falls, and the sixty-foot tall Ohio Edison dam at RM 42.6.
- Upstream of RM 49.8, the measurements may show differences between dam-pool conditions and free-flow conditions. Flow was restored at the Kent dam in 2004 and at the

Munroe Falls dam in October, 2005. The dam at Plum Creek upstream of Cherry St. was removed in spring, 2010. Measurements prior to these dates reflect dam-pool conditions, after these dates reflect freely flowing conditions.

- The Portage Path stream gage showed increased flows during July 11-12, 2007, suggesting stormwater influence. During another period of interest, September 19-20, 2007, the Portage Path stream gage recorded extremely low flow typical of dry summer periods, less than 100 cubic feet per second.

The chemistry data suggest that all the subwatersheds have some level of nutrient enrichment, with different sources of influence:

- The phosphorous data for the Cuyahoga River after dam removal indicates that phosphorous levels exceeded state and EOLP targets during July 11 and 12, 2007, immediately following a rain event, suggesting that non-point source pollution/runoff contributes to the phosphorous loading. Nitrate+nitrate levels frequently exceeded state and EOLP targets. Levels increased both during the rainy July 11-12, 2007, period, and also during the extremely low-flow period in 9/19-20/2007, possibly indicating influence from non-point source pollution as well as wastewater treatment plants.
- The Lower Cuyahoga River TMDL noted TP levels in 2000 ranging from 0.05 to 0.6 mg/l, with a median 0.17 mg/l, which exceeds the 0.12 mg/l target for small rivers. National Park Service measurements at Ira Road in the Lower Cuyahoga averaged 0.22 mg/l.
- The WWH portion of Fish Creek exceeded the EOLP phosphorous target for WWH headwaters several times, including during the rainy period of July 11, 2007. The levels upstream at Spaulding Rd. were approximately half as high as at North River Road, which is downstream of an area with denser and older development, and which likely lacks stormwater controls that were instituted in recent years.
- Plum Creek at Cherry St. (downstream of the former Plum Creek dam pool) exceeded EOLP phosphorous target three times, once during the rainy period of July 11-12, 2007. At Tallmadge Road, Plum Creek equaled the EOLP phosphorous target. The nitrate+nitrite levels were twice as high at Tallmadge Road as at Cherry Rd. It should be noted that the upstream portions of Plum Creek are heavily channelized, and Plum Creek subwatershed has undergone rapid development since 2000. Should development and alteration of riparian features continue, nutrient enrichment in this portion of Plum Creek may increase.
- Breakneck Creek at the lower end exceeded state and EOLP targets for both phosphorous and nitrate+nitrite during most of the measurements in 1998 and 2007. There are two wastewater treatment plants upstream, and this is the most heavily urbanized portion of the watershed. The measurements during the rainy July 11-12 2007 period were higher than others. Breakneck Creek at Summit Road and RM 14.6 exceed EOLP targets for both nitrogen and phosphorous in measurements taken during 2000. Because the sample dates differed from the upstream and downstream portions of Breakneck Creek, it is difficult to trace patterns from upstream to downstream.
- Potter Creek exceeded EOLP targets for both nitrogen and phosphorous in one sample in July, 2000, and equaled or exceeded EOLP targets during the other July, 2000, sample.
- The Feeder Canal exceeded EOLP targets for phosphorous in two samples taken in 2000, and exceeded nitrogen targets in one sample.
- Nutrient levels in Congress Lake Outlet measured for a Masters Degree thesis indicated that two sites at the upstream end, toward Congress Lake, exceeded EOLP targets for MWH waters. Nitrate levels exceeded EOLP targets of Nitrate + Nitrite at most of the sites in the spring samples, and at the furthermost upstream sites in the winter samples.

Dissolved Oxygen

Dissolved Oxygen

The 2003 TMDL notes that dissolved oxygen was the primary chemical component below RM 48.9 not meeting WWH standards (5 mg/l average, 4 mg/l minimum over 24 hours). The TMDL notes that low dissolved oxygen was a concern in the Lower Cuyahoga. However, the only exceedences of the dissolved oxygen criteria listed in the 2003 TMDL occurred along the Feeder Canal at Saxe Rd. and Breakneck Creek at Summit Rd., both in July, 2000. Low dissolved oxygen was reported at numerous locations downstream, and some may have been influenced by oxygen demanding substances or nutrients from upstream. The TMDL notes that CSOs and waste water treatment plants contribute oxygen demanding substances. There are no wastewater treatment plants in between Brust Park and the Ohio Edison Dam. There are four CSOs in the Gorge section of Cuyahoga Falls. As discussed previously, dissolved oxygen deman and swings in saturation levels are related to nutrient levels and algal activity, as well.

- The 2003 Lower Cuyahoga River TMDL notes diurnal swings of 80 percent in oxygen saturation levels at several stations (mostly dam pools) between Water Works Park and the Little Cuyahoga in August 2001, with values as low as 40 percent and as high as 160 percent. The values immediately downstream of the then-present Munroe Falls dam ranged from 80 to 100 percent.
- Dissolved oxygen exceedences occurred at the Feeder Canal/Potter Creek at Saxe Road (4.44 mg/l) and Breakneck Creek at Summit Rd. (4.6 mg/l) on July 19, 2000.
- The 1999 TSD did not report any oxygen exceedences along the Middle Cuyahoga River.
- The 2000 TMDL reported that 24-hour average dissolved oxygen levels taken in 1996 throughout the river between Brust Park (RM 49.9) and Lake Rockwell ranged from 2.66 to 4 mg/l, with minima of 0-3 mg/l. Both daily average and minimum readings failed to meet state criteria for the summer low-flow (critical) period. The 2000 TMDL noted that the impoundments and flow modification altered the flow hydraulics, reducing the ability of the stream to assimilate nutrients and incorporate oxygen. However, with restoration of free-flow conditions, the dissolved oxygen levels consistently exceeded 7 mg/l.
- The 2003 Lower Cuyahoga TMDL listed bacteria and phosphorous as the impairing causes of non-attainment. Low dissolved oxygen was described as an impairing cause that was not load-based.

4e-1b Lakes Quality

Findings:
Lakes Quality

Lake Hodgson is monitored as a public water supply. Ohio EPA has conducted studies on Congress Lake because of its eutrophic condition. Kent State faculty have recently installed monitoring equipment in Sandy Lake and Twin Lakes, with the permission of the lake associations.

Lake Hodgson

Water from Lake Hodgson meets drinking water standards. The City of Ravenna notes that taste and odor are constant concerns related to Lake Hodgson water. Monitoring indicates chlorophyll counts in the upper 25 feet increase periodically during the year. In the spring, counts rise from less than four mg/l to 6-7 mg/l. In the summer, there is a dramatic increase in chlorophyll counts, as high as 23 mg/l. For most of the year, when the control structures are closed, the watershed of Lake Hodgson is quite limited, less than seven square miles. Flow in the Feeder Canal when the control structures are closed indicates groundwater flow into the Feeder Canal. Throughout the year, the levels of phosphates at the surface remain relatively constant at 0.05 to 0.08 mg/l, with the highest levels in August. However, in August, as lower depths of this kettle lake become anoxic, the levels of phosphates at depth increase to 0.16 mg/l, twice that of the surface measurements, suggesting that phosphates are remobilizing from the sediment under anoxic conditions. The increase in chlorophyll levels coincide roughly with the increases in phosphates.

Determining the inputs to Lake Hodgson is complicated by the connection to Congress Lake, via the Feeder Canal-Congress Lake Outlet, which is occasionally opened during the dry summer months. During that period, the watershed size increases dramatically. In addition, the connection allows the hyper-eutrophic water to flow from Congress Lake into the Lake Hodgson system. This system should be studied further to determine the source of nutrients.

Congress Lake

Congress Lake is a privately owned, hyper-eutrophic lake that has experienced nuisance algae blooms. It is of concern, because it is at the head of the watershed for Lake Hodgson when the control structure is open, and Breakneck Creek when the control structure is closed. Ohio EPA, the Portage and Stark County health departments, and Portage County SWCD have investigated potential sources of nutrients to the lake. The Ohio EPA report on Congress Lake indicated that an investigation of a nearby farm operation was inconclusive. The drainage tiles at this farm have since been destroyed. Potential sources of nutrients include nearby septic systems, the golf course, agricultural runoff, and legacy sediments in the kettle lake. The lake association has apparently installed deep aerators to reduce anoxic conditions at depth.

4e-1c Water Quality Attainment - Wetlands

Wetlands Quality: Background – Altering Wetlands

Effects of Altering Wetlands

Since early settlement times, wetlands have been altered to reduce flooding, make use of fertile wetland soils for agriculture, reduce mosquito breeding areas, or develop the landscape. However, altering wetlands reduces the important functions they provide for watersheds, increasing flooding problems, pollution, removing valuable habitat. Furthermore, wetlands are not well suited for development and may also present difficult moisture conditions in which to grow crops, unless the water regime is managed. Even when they are filled or drained, or their soil is removed, the conditions that allowed water to collect and remain in the soil often persist. In many cases, altered wetlands collect and retain water during storm events, creating flooding problems, instability, septic system failures, wet basements in areas developed on wetlands, and marginal areas for crops.

Regulating wetland alteration

The U.S. Army Corps of Engineers, U.S. EPA, and Ohio EPA regulate discharges to (filling of) wetlands and other waters. Filling or altering wetlands generally may be permitted only if:

- There is a demonstrated justification,
- No other alternatives to filling in the wetland,
- Alteration is minimized, and
- The negative impacts from alteration compensated for through mitigation.

In considering whether proposed alteration is justified, these agencies assess the value of the wetlands being altered or used, the watershed functions that would be lost or degraded by use of or alteration to the wetlands.

State water quality regulations include a mandatory antidegradation requirement that prohibits lowering water quality unless it is demonstrated to be necessary and unavoidable. In Ohio, the degree of justification needed to use the resource and the minimization/mitigation requirements depend on the wetland category assigned through a functional assessment. The Ohio EPA has developed the Ohio Rapid Assessment Method, ORAM, which provides the basic data needed to determine the wetland category.

- Category 1 wetlands are considered of limited value for habitat and/or wetland functions. They are often degraded by invasive species and tend to be isolated from flowing water. Because of the limited amount of functions they provide, the Ohio Revised Code (ORC) 3745-1-05(A) identifies them as “limited quality waters.” The Ohio EPA does not require social or economic justification to use or alter them, and lower standards of avoidance, minimization, and mitigation apply.

  Ranking a wetland as category 1 means it provides less value and function compared to Category 2 or 3 wetlands. Examples include depressions or wet agricultural lands. However from a watershed perspective, these features may still provide important functions, even if their value for habitat has been severely degraded. For example, in urbanized settings, the habitat value of wetlands may be severely degraded, but they may be the only natural landscape features remaining to provide flood storage and pollutant/nutrient uptake.

- Category 2 wetlands make up the large category between categories 1 and 3. They support “moderate” wildlife habitat or hydrological functions, and serve as functioning, diverse, healthy water resources providing ecological integrity and human value. Some category 2 wetlands are considered degraded but retain enough existing or potential functions that they could be restored. Determination of category 2 “degraded” is not intended to allow further degradation.

- Category 3 wetlands provide the highest level of habitat quality and hydrological functions. These include high levels of diversity, native species, and hydrological function. These contain or provide habitat for threatened or endangered species and include mature wetland mature forested wetlands, bogs, fens, vernal pools, or regionally scarce habitats. Classification as Category 3 is based on having some but not necessarily all of the high value attributes. For example, a flood-plain wetland might be considered high value even if without a mature forest. Reducing the quality of category 3 wetlands is permitted only if it is demonstrated that the alteration is necessary to meet a public (i.e., societal) need.

In a recent study, the Cuyahoga River RAP compared mapped wetlands and landscape characteristics with ORAM scores of sample wetlands in several subwatersheds of the Cuyahoga River. The study found that high ORAM scores and the greatest value for habitat and other wetland functions, such as groundwater recharge, occurred in wetland complexes of the greatest diversity and size.

Mitigation for Permitted Filling of Wetlands

Often when filling wetlands is permitted, the regulatory agencies require compensatory mitigation to replace the lost functions. Replacement can be on-site or off-site in larger combined wetland mitigation areas/banks. Mitigation banks are large-scale constructed wetlands that are funded through mitigation credit fees. Federal permitting agencies favor replacing wetlands in mitigation banks. The Ohio EPA favors replacing lost wetland functions on-site. There are no wetland mitigation banks in the Cuyahoga River watershed. Instead, wetland mitigation credits are used to extend wetlands in the Grand River watershed or others draining to Lake Erie. However, wetland mitigation does not necessarily have to occur within mitigation banks. Any approved wetland restoration, construction, or enhancement project can be used as mitigation for impacts elsewhere. The Ohio EPA has established a clearinghouse where designed wetland projects can be used to mitigate impacts.

Findings:
Wetland Alteration and Quality

Findings: Wetland Alteration

The hydric soil mapping is a likely indicator of where wetland conditions existed in the past. Because aerial mapping of wetlands is uncertain, it is difficult to determine visually just how much of the former wet landscape has been altered. Existing land cover was compared with the extent of hydric soils to identify areas where non-wetland land cover occurs on hydric soils, indicating areas where wetlands have likely been altered, reducing the watershed services they perform in an area. In areas that were already urbanized when the soils were mapped, the hydric status of the soils could not be determined.

The CCAP land cover data was overlain on mapping of hydric soils and soils with hydric inclusions. Land cover mapped as woods or wetland on hydric was assumed to be wetland, mapped as some other use was assumed to be altered. This does not include the County wetland mapping and should be used as a general guide of where wetlands may have been altered and where it may be possible to restore wetland functions. The results are summarized in Table 4e-7 and Figure 4e-2.

As shown on Figure 4e-2 and Table 4-e7, a substantial amount of hydric soils have been converted to developed, developed open space, or agricultural use since the 1970s, when the soil maps were developed. This is consistent with accounts of substantial wetland loss in this region. Historical accounts of early settlement note extensive efforts to muck out swamps.

Table 4e-7 Non-Wetland Land Cover on Hydric Soils

Subwatershed	Hydric/ Hydric Incl.	Converted to Developed (ac)	Converted to Devel. Open Space (ac)	Converted to Agric. (ac)	Converted to Barren (ac)	Total
Main Stem	H	243	170	39	0	451
	HI	1,495	537	134	0	2,167
Fish Creek	H	305	274	153	3	734
	HI	832	581	44	3	1,461
Plum Creek	H	248	157	267	26	697
	HI	283	197	440	25	946
Breakneck Cr.	H	518	175	1,044	2	1,739
	HI	1,753	499	3,784	2	6,039
Potter Cr.	H	137	53	2,379	16	2,585
	HI	575	262	3,941	42	4,819
Total	H	1,451	827	3,882	47	6,207
	HI	4,938	2,077	8,344	73	15,432

- In Stark County, the extensive area of hydric soils along the Congress Lake Outlet is the site of muck farms, where farmers raise and lower the water table regularly to take advantage of the fertile muck (organic) soils.

- Cranberry Creek, Randolph Ditch, Hudson Ditch, Brimfield Ditch (western tributary), Fish Creek, and portions of Plum Creek appear to have extensively altered (drained) wetlands. These have lost the substantial benefits provided by functioning wetlands.

- Three of the areas described as having repeated flooding problems, headwater tributaries to Walnut Creek, Brimfield Ditch at Breakneck Creek, and the southern portion of Fish Creek in Kent, occur along or at the downstream end of streams flowing through altered (ditched, channelized) wetlands: Each of these areas is in a developed or developing landscape. It is worth considering whether the wetland loss and development are related to the flooding problems: the development would generate additional stormwater, and converting wetlands would substantially reduce flood storage to handle the additional load. It is also worth considering whether restoring wetlands in these areas could help alleviate flooding problems nearby.

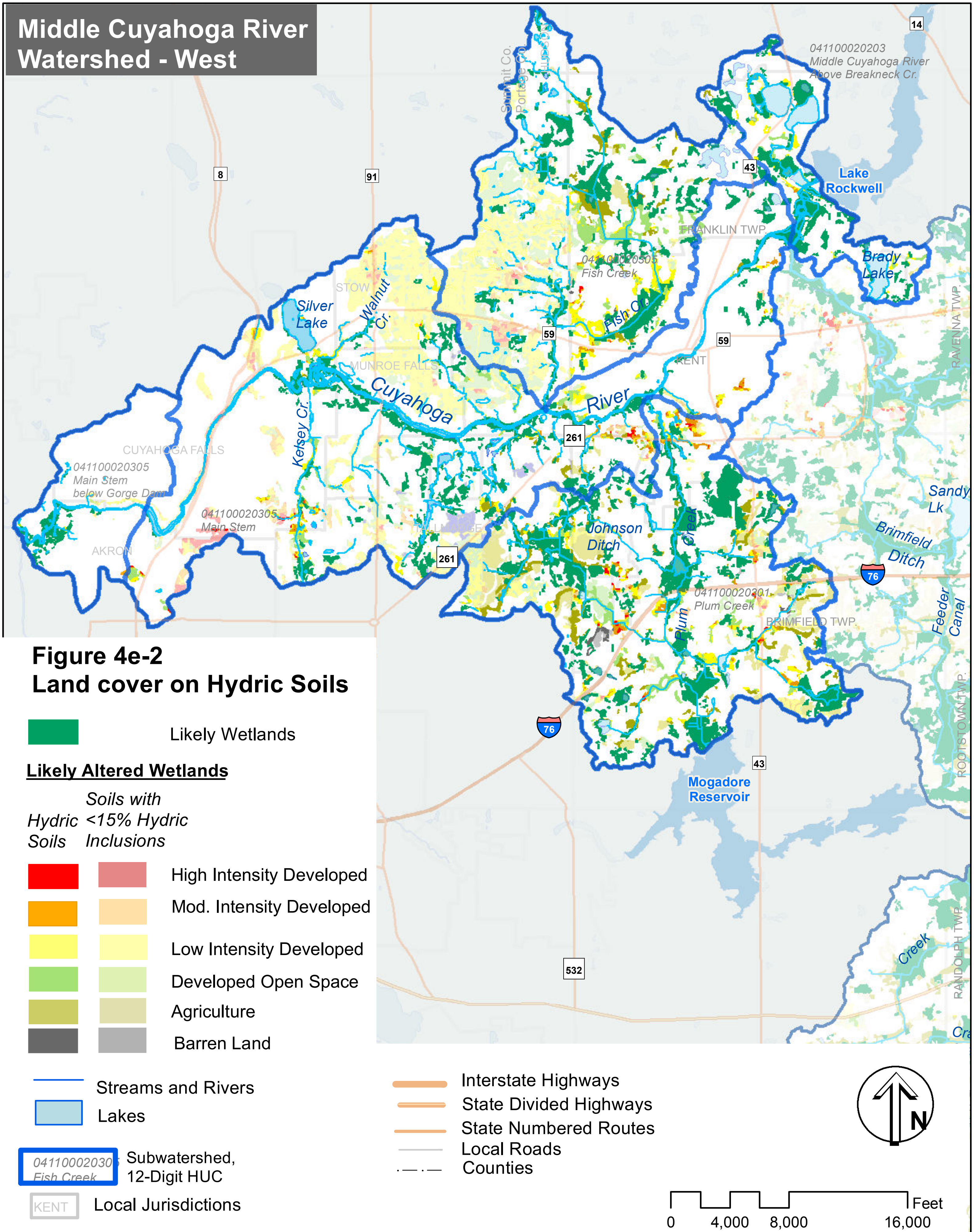
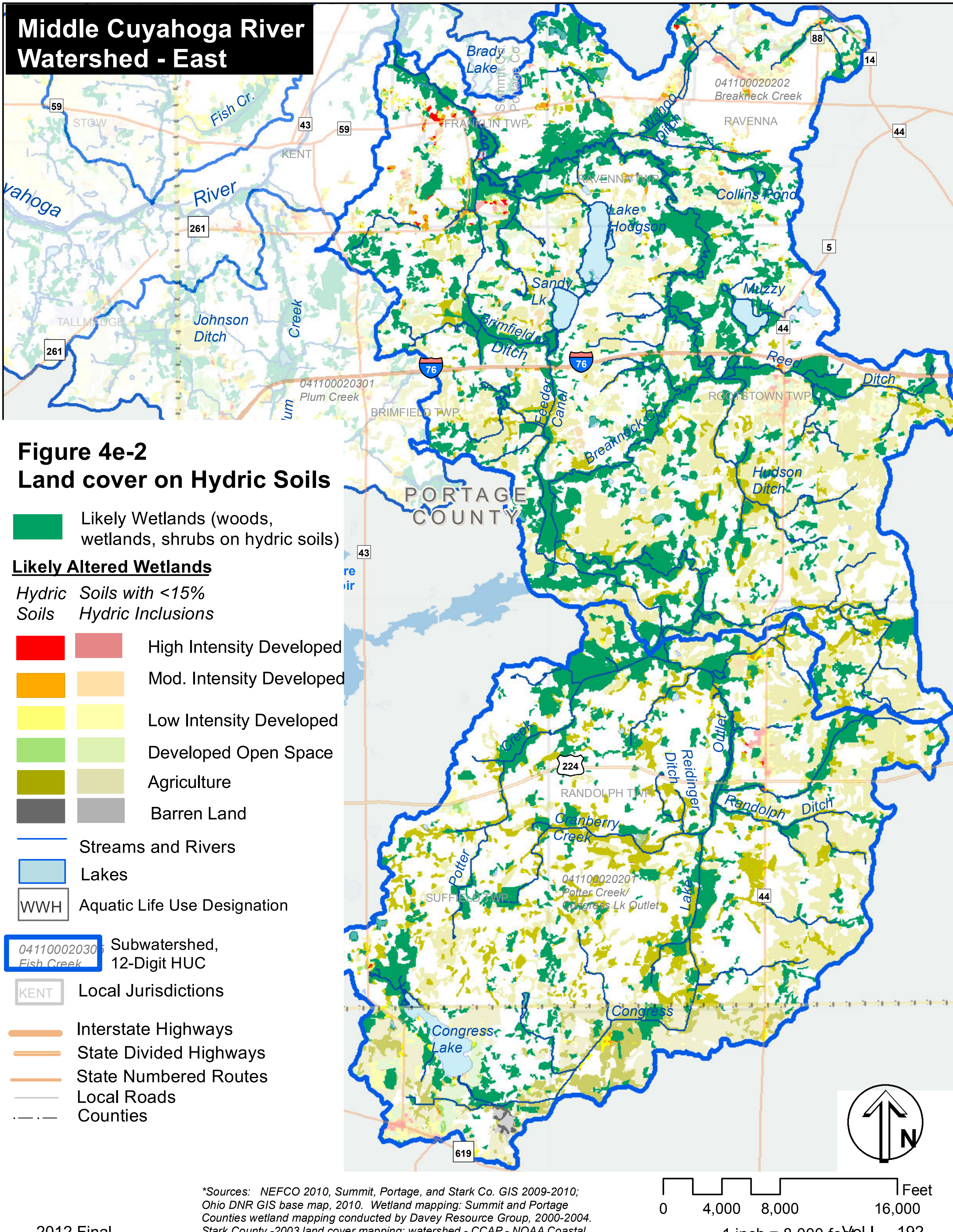


Figure 4e-2
Land cover on Hydric Soils

Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2010.
Wetland mapping: Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004.
Stark County -2003 land cover mapping; watershed - CCAP - NOAA Coastal Change Analysis Program 2006 mapping.



Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2010. Wetland mapping: Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; watershed - CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

- In other cases, (e.g., Walnut Creek headwaters and lower end, Collins Pond, etc.) community officials report that where wetlands (hydric soils) have been converted to development, properties experience repeated flooding.

- Soils described as having hydric inclusions were also compared with developed/agricultural areas, as these areas probably contained smaller wetlands on the patches of hydric soil included in other types. While other, poorly drained soils may also show wetland conditions, these areas were not included specifically in the mapping if they were not listed as either hydric soils or soils with hydric inclusions.

- A comprehensive assessment of wetland quality has not been conducted. Encroachment of development or agriculture can degrade wetlands, so they no longer receive the regulatory protection they once did. Mapping done for a proposed project in the Fish Creek watershed indicates the large remaining wetlands have been degraded, requiring a substantial investment to remove invasive species. Undisturbed, larger, and more complex systems, such as along Breakneck Creek, Plum Creek, and portions of Potter Creek, likely retain their high quality.

It may be possible to restore some wetland functions in hydric soils in agricultural or urban recreational lands. Hydric soils converted to developed uses are much less likely to be restored. Where intact wetland systems remain, it would be beneficial to afford them some protection.

4e-1d Water Quality Attainment - Groundwater

Potential Groundwater Contamination

Inventoried Sites

The Kent Source Water Protection Plan and Ohio EPA Division of Environmental Response and Revitalization database indicate the presence of several uncapped or abandoned landfills and other potential sources of contamination, shown on Figure 4e-3. Several are found near the Kent wellfield, fewer are in the vicinity of Cuyahoga Falls, Lake Hodgson, or Portage County supplies. According to the Source Water Protection Plan, the old Kent dump is on the opposite side of a groundwater flow divide from the wellfield. Determining the status of the other sites is important, as is monitoring near the wellfields for potential contamination.

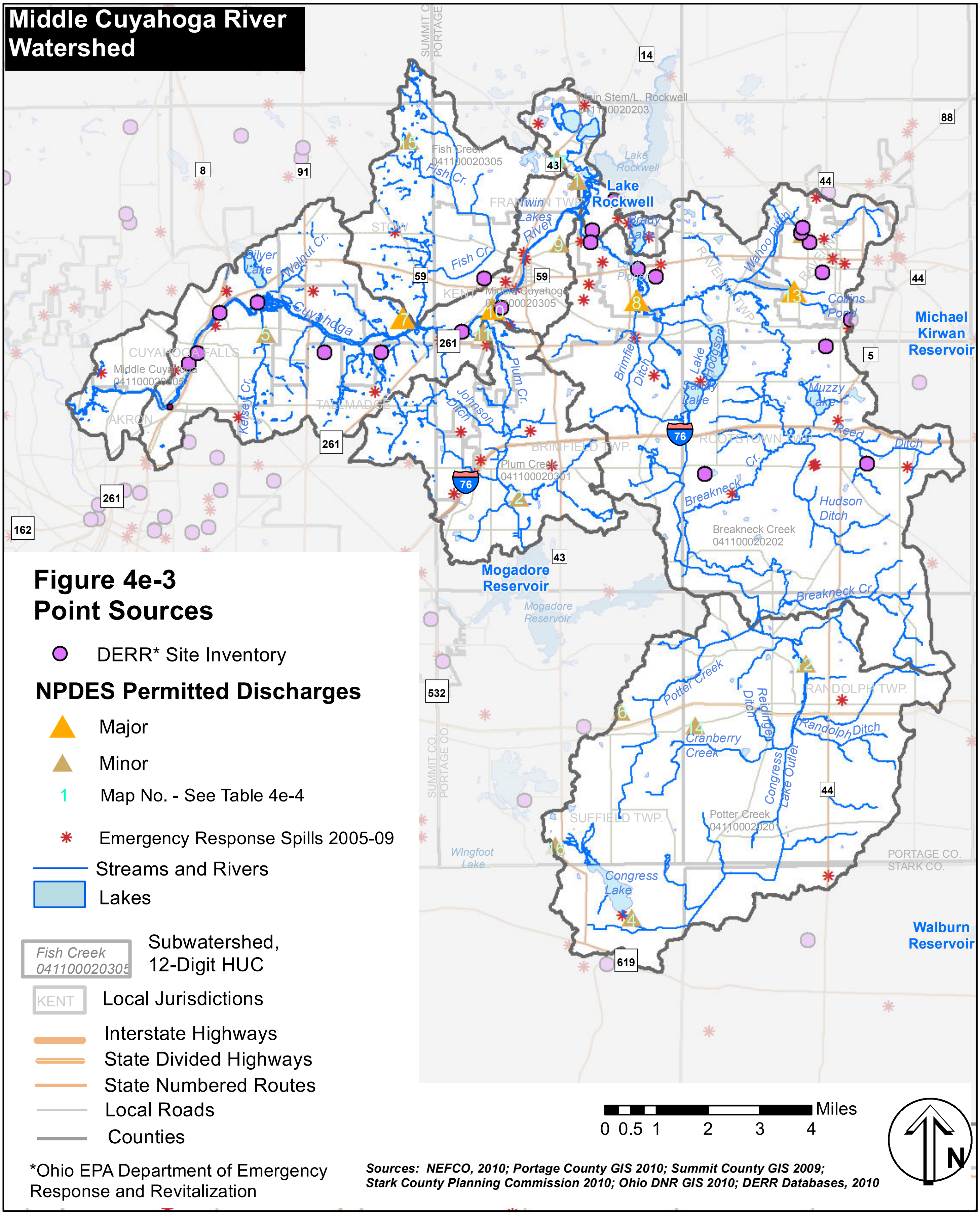
Oil and Gas Wells

One area of potential concern expressed by watershed partners is contamination of groundwater supplies from oil and gas wells. Potential sources of contamination include

- fracturing of the well casings, allowing petroleum products to enter the groundwater;
- spills and improper disposal of brine;
- contamination of groundwater supplies from hydraulic fracturing (fracking) used in stimulating deep wells in the Marcellus and Utica Shales.

Local governments do not have jurisdiction over siting the oil and gas wells, which are regulated, permitted, and inspected by the Ohio DNR Minerals Management program. According to Ohio DNR staff, communities can request notification of permits applications and can work with the DNR County inspectors to identify potential risks and conditions to minimize risks. Knowledge of the location of the most sensitive surface and groundwater resources is important in protecting water supplies.

Recent measures have increased the level of protection in drilling and stimulating deep wells. Fluids used to conduct the hydraulic fracturing must be disposed of in underground injection control wells, which are regulated by the Ohio EPA. The debates over the safety of this process will continue, in response to recent reports of groundwater contamination resulting from hydraulic fracturing processes.



Middle Cuyahoga River Watershed
Figure 4e-3
Point Sources
DERR* Site Inventory
NPDES Permitted Discharges
Major
Minor
Map No. - See Table 4e-4
Emergency Response Spills 2005-09
Streams and Rivers
Lakes
Fish Creek 041100020305
Subwatershed, 12-Digit HUC
KENT
Local Jurisdictions
Interstate Highways
State Divided Highways
State Numbered Routes
Local Roads
Counties
*Ohio EPA Department of Emergency Response and Revitalization
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; DERR Databases, 2010
Miles
0 0.5 1 2 3 4
N
Lake Rockwell
Michael Kirwan Reservoir
Mogadore Reservoir
Walburn Reservoir
Fish Creek 041100020305
Main Stem/L. Rockwell 041100020203
Middle Cuyahoga 041100020305
Plum Creek 041100020301
Breakneck Creek 041100020202
Potter Creek 041100020201
STOW
KENT
CUYAHOGA FALLS
AKRON
TALLMADGE
BRIMFIELD TWP.
ROOTSTOWN TWP.
RANDOLPH TWP.
SUFFIELD TWP.
PORTAGE CO.
STARK CO.
SUMMIT CO.
Cuyahoga
Fish Cr.
Walnut Cr.
Silver Lake
Plum Cr.
Johnson Ditch
Breakneck Cr.
Potter Creek
Cranberry Creek
Congress Lake
Hudson Ditch
Muzzy Lake
Collins Pond
Reed Ditch
Randolph Ditch
Wingfoot Lake

4e- 2 Point sources
-a Permitted Discharges, effluent volume

As shown on Figure 4e-3 and Table 4e-8, within the watershed are four major and 12 minor permitted dischargers. The major dischargers are the wastewater treatment plants along the Cuyahoga River and its tributaries, which, under their expansions in 2007, contribute up to 20 million gallons per day (MGD). According to the 2007 Ohio EPA 2007 Cuyahoga River Aquatic Life Use Assessment report, this constitutes 53 percent of the volume during low flows before expansion and 56 percent afterward. Releases from Lake Rockwell constitute about 16 percent of the river flow.

Table 4e-8
NPDES Point Source Dischargers

Map No.	TYPE	Major/ Minor	Site	Address	City/Village/ Township	Avg. Flow (mgd)	Monitored/ Design Flow
1	I	Minor	Akron WTP	1570 Ravenna Rd	Kent	1.1	M
2	I	Minor	Brimfield WTP	3785 Grace Rd	Ravenna	0.027	D
3	I	Minor	Colonial Rubber Co	706 Oakwood St	Ravenna	0.002	D
4	P	Minor	Congress Lake Clubhouse	1 East Dr	Hartville	0.015	D
5	I	Minor	Cuyahoga Falls WTP	2028 Munroe Falls Ave	Cuyahoga Falls	0.115	D
6	P	Minor	Fairlane WWTP	1879 Whitehall Dr	Suffield Twp	0.03	D
7	P	Major	Fishcreek WWTP No 25	2910 N River Rd	Stow	8	D
8	P	Major	Franklin Hills WWTP	5756 Hodgeman Ln	Portage	2	D
9	I	Minor	Gougler Industries Inc	705 Lake St	Kent	0.000355	M
10	P	Major	Kent Water Reclamation Facility	641 Middlebury Rd	Kent	5	D
11	I	Minor	Parker Hannifin Corp Brass Products Div	838 Overholt Rd	Kent	0.021	D
12	P	Minor	Randolph WWTP	2053 State Rte 44	Ravenna	0.3	D
13	P	Major	Ravenna STP	3722 Hommon Rd	Ravenna	2.8	D
14	P	Minor	St Joseph Parish WWTP	2643 Waterloo Rd	Randolph	0.015	D
15	I	Minor	Sun Pipe Line Co Hudson Pump Station	5161 Young Rd	Stow	0.037	M
16	I	Minor	Trelleborg Wheel System Americas Inc	61 State Route 43 N	Hartville	0.049	D
17	P	Minor	Twin Lakes WWTP	7240 State Rte 43	Kent	0.456	D
	I = industrial			*total*		19.96736	
	P = public						

4e-2b Point Sources - Spills

Figure 4e-3 shows spills from 2004-2009 included in the Ohio DNR Division of Environmental Response and Revitalization database. The database may not reflect all spills. Most are concentrated along the major roads. These can be of concern to public water supplies.

4e-2c Point Sources – Combined Sewer Overflows

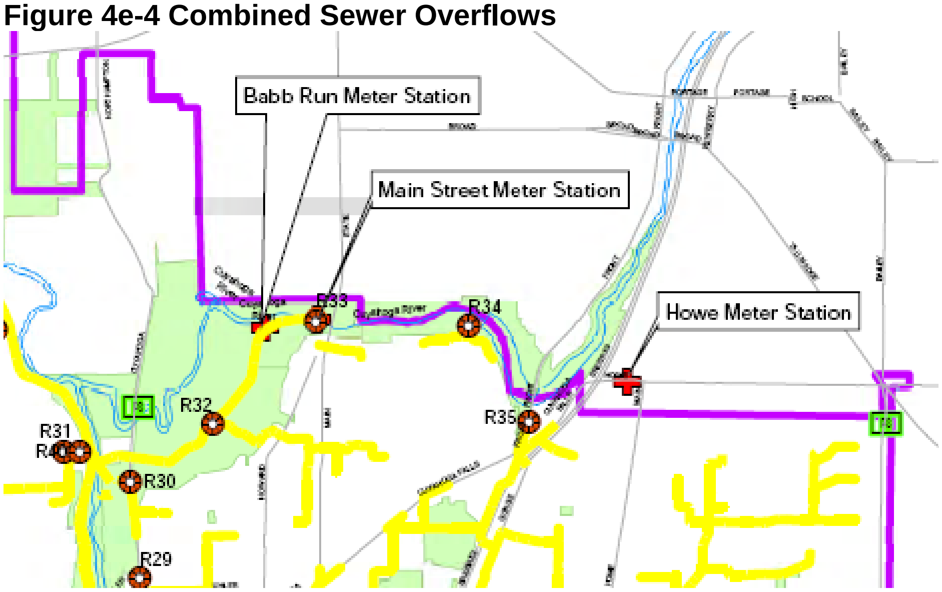
Combined Sewer Overflows (CSOs) occur where storm and sanitary sewers have been physically combined and discharge without passing through a waste water treatment plant, discharging raw sewage into the rivers. CSOs have been identified as the source of oxygen demanding substances and bacteria violations, which are concerns to a degree in the Middle Cuyahoga River watershed, and which are major concerns for the river downstream.

CSOs operate under National Pollutant Discharge Elimination System (NPDES) permits, as they constitute discrete discharges to water courses. The City of Akron has 37 CSOs along the Cuyahoga and Little Cuyahoga Rivers, four of which occur upstream of the Little Cuyahoga River. (See Figure 4e-4 and Table 4e-9.) Under the 2010 NPDES permit, each discharge of untreated sanitary waste is considered a violation and must be monitored.

The City of Akron has been performing studies and developing designs since the 1990s to address the CSOs. Their results indicate that:

- No areas of the Cuyahoga River within the CSO area fall below the 5 mg/l dissolved oxygen criterion
- Bacteria levels remain elevated above ambient conditions in the Cuyahoga River upstream of the confluence with the Little Cuyahoga.
- The Cuyahoga River within and downstream of the CSO area has difficulty meeting bacteriological standards for 5-6 months of the recreational season (May 1-Oct. 31).
- Upstream at Broad Street in Cuyahoga Falls, the river fails to meet bacteriological standards every month during the recreational period. The source is undetermined.

Figure 4e-4 Combined Sewer Overflows



Source: City of Akron Long Term Control Plan Amendments 2011

Table 4e-9 CSOs and Discharges

CSO Station No.	Typical Number of Annual Discharges 2010	Avg. Volume per Discharge (millions of gallons)
32	37	15.3
33	3	0
34	48	2.8
35	29	46.7

The City of Akron has submitted to the U.S. EPA a Long Term Control Plan that calls for a 20-foot wide tunnel 10,000 feet long to contain all discharges from the four CSOs within the watershed. The LTCP includes a stipulation that to the extent that green infrastructure can achieve the same result, it will be allowed as an alternative. Additional sources of high bacteria levels upstream of the CSO area should be determined as well.

4e-3a Non-point sources: Home Sewage Treatment Systems

Septic system failure and above-ground discharging systems can be a significant source of water quality problems, introducing nutrients and pathogens into surface waters**.** In 2000, agencies from seven northeast Ohio counties collaborated on a home sewage system study to document the conditions most likely to result in septic system failure. They found that certain soils limitations were the most likely to result in failure: Soils rated “severe” limitations for septic systems exhibiting a combination of seasonal high water table, ponding, and slow permeability.

Portage County Health Department staff indicated that in these severely limiting soils, it can be assumed that 70 percent of the septic systems of older homes built before 1990 would fail. More recent homes have been constructed using different procedures for septic systems, which address factors such as soils limitations and depth to bedrock. The more recently constructed septic systems tend to use newer construction methods as well, such as mound systems, which substantially reduce the rate of failure.

When septic systems fail, remedies can include cleaning, upgrading, or replacing septic systems or tying into a sewer system, if available. Recent construction of the Randolph wastewater treatment plant addressed frequent septic system failures in that area. Surface discharging systems are currently prohibited. However, since many were installed under previous rules, they constitute a permitted system, and compelling the owners to upgrade may prove difficult.

It should be noted that Portage County has recent (2010) begun implementing its new stormwater program County-wide. The program includes an emphasis on investigating potential illicit discharges and seeking correction of the problem. The County has enacted a stormwater fee, a portion of which is intended to help homeowners remedy failing or inadequate home sewage disposal systems.

Findings:
Home Sewage Treatment Systems

Findings: Home Sewage

Figure 4e-5 shows the soils characterized by the number of limitations for septic systems, overlain by mapping of existing and proposed sewer service. Breakneck Creek and the remaining unsewered portion of the Fish Creek subwatersheds predominantly have soils with severe limitations, reflecting the poorly draining and often hydric soils. The Potter Creek subwatershed has much less severely limiting soils. It should be noted that the soils in the proximity of Congress Lake are severely limiting. The unsewered portion of the Plum Creek subwatershed has minimal severely limiting soils.

The Portage County Health District has developed a database identifying potential illicit discharges, with an estimate of 3,445 suspected illicit discharges in the county and 1,457 in watershed communities as of December 30, 2011. Table 4e-10 summarizes the number of potential illicit discharges identified by township. Estimates of amount for the watershed were based on the presence of severely limiting soils and sewered areas in the watershed.

Approximately 437 systems in watershed communities are in annual inspection programs. In addition, Portage County Health Department investigates reports of illicit discharges. In 2011, Portage County Health Department inspected 119 suspected illicit discharges in Portage County, of which 52 were confirmed, 22 were addressed, and 30 are pending resolution. As shown on Table 4e-11, Portage County Health Department inspected 59 suspected illicit discharges in watershed communities, of which 25 were confirmed, seven were eliminated during 2011, and 18 are pending replacement or repair.

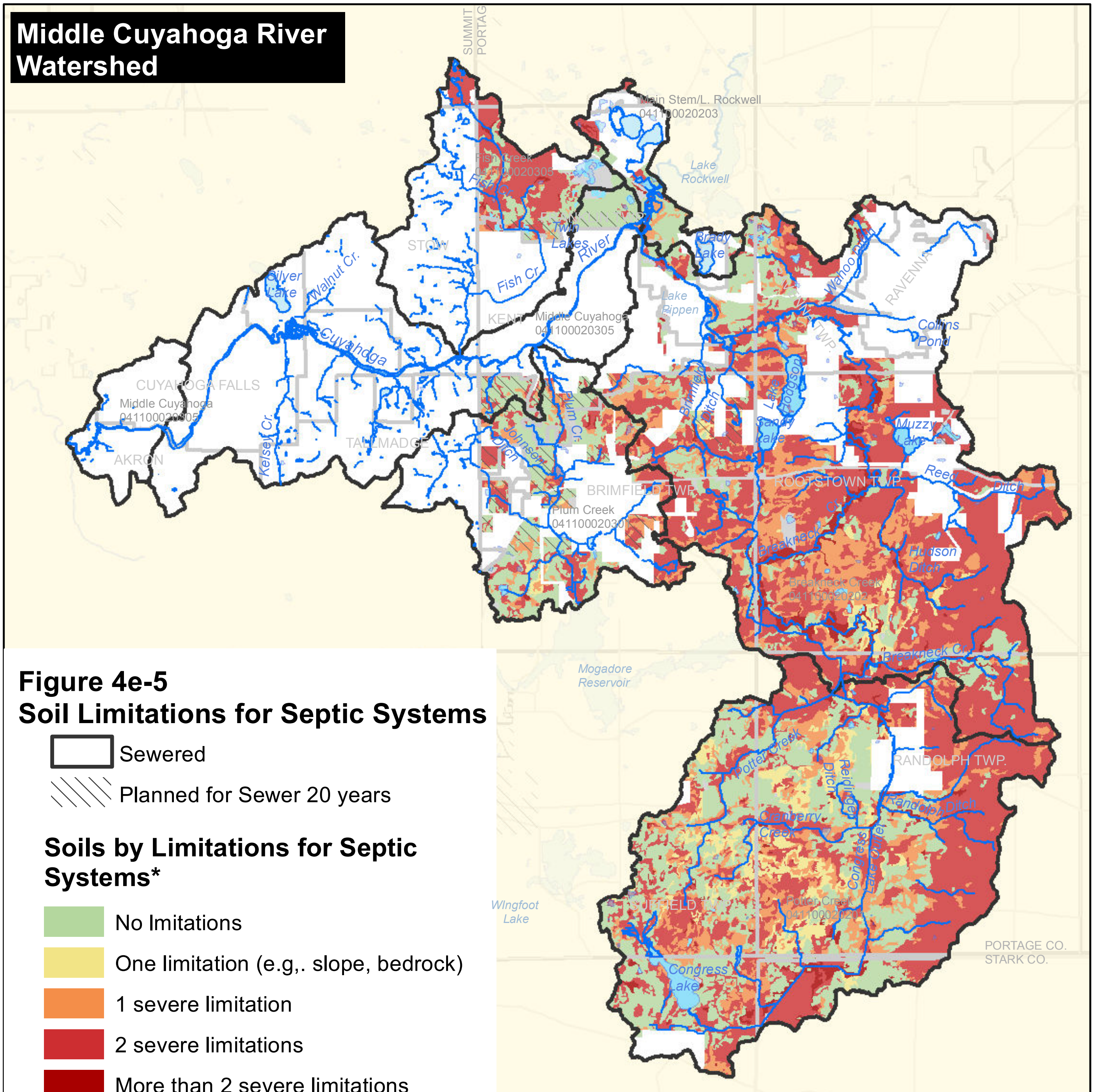


Figure 4e-5
Soil Limitations for Septic Systems

Sewered

Planned for Sewer 20 years

Soils by Limitations for Septic Systems*

- No lmitations
- One limitation (e.g,. slope, bedrock)
- 1 severe limitation
- 2 severe limitations
- More than 2 severe limitations
- Water
- Rock or gravel pits
- Streams and Rivers
- Lakes and Ponds

041100020305 Subwatersheds with 12-digit HUC number

Jurisdictions

Main Roads

* Northeast Ohio Sewage Report notes that septic system failures were most likely in soils that were identified as having two or more severe lmitations to septic systems.

Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; SSURGO soils database; Clean Water Plan prescriptions Lake Erie Basin; Portage and Summit Cou Ohio Sewage Report

0 0.45 0.9 1.8 2.7 3.6 Miles

N

Table 4e-10 Potential Illicit Discharges in Portage County, 2011

Township	Estimated Potential Illicit Discharges by Township 2011	Systems in Annual Inspection Program	Other Potential Illicit Discharges	Estimate in Watershed Based on soils 2011
Brimfield	200	78	122	*
Franklin	161	30	131	110
Randolph	188	45	143	94
Ravenna	436	137	299	109
Rootstown	372	99	273	279
Suffield	103	48	55	25

*Minimal soils with severe limitations, but potentially some failing aeration systems near the northeast border with Tallmadge.

Table 4e-11 Inspections and Corrections of Illicit Discharges in Portage County, 2011

Township	Suspected Illicit Discharges Inspected	Total Confirmed Illicit Discharges	Total Illicit Discharges Eliminated	Total Illicit Discharges Pending Replacement/ Repair
Brimfield	13	8	0	8
Franklin	4	2	1	1
Randolph	6	2	1	1
Ravenna	16	8	2	6
Rootstown	4	2	1	1
Suffield	6	3	2	1

The Portage County Health Department is continuing to address illicit discharges by inspecting storm drains for dry weather discharges.

The Stark County Health Department indicated that there have been septic system failures in Stark County townships within the watershed, and that measures were being taken to correct failing systems in the vicinity of Congress Lake.

4e-3b New homes

Figure 4a-25 shows concentrations of development activity in Portage County prior to the economic downturn. In Summit County, only a few large parcels remain. In Portage County, considerable development was proposed in Brimfield and Rootstown near Route I-76. Once the economy rebounds, these are likely sites of future development, as platted subdivisions are built. The hummocky terrain increases the potential for erosion and sedimentation.

4e-3c Animal feeding operations

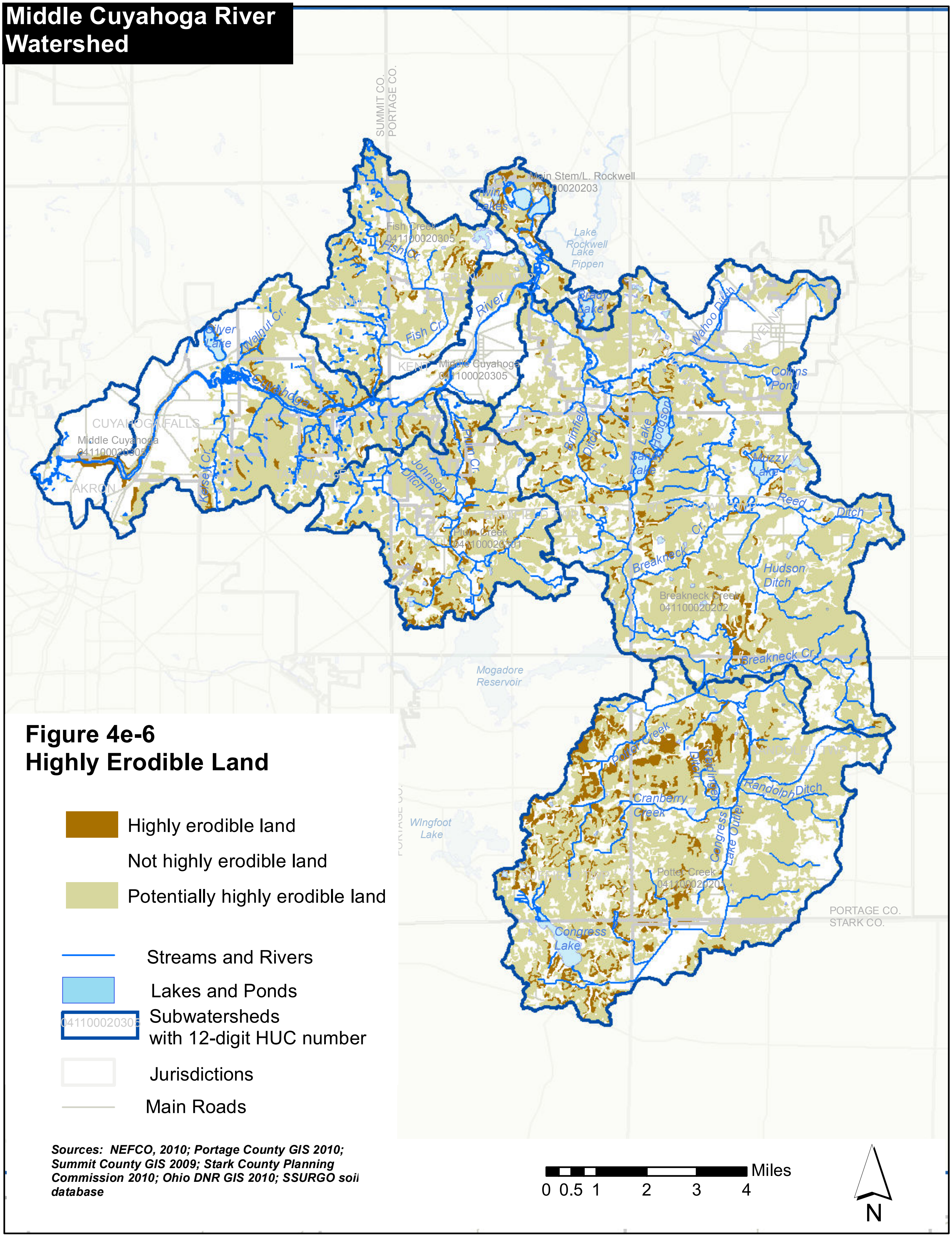
The Ohio EPA online database indicates there are no concentrated animal feeding operations in the watershed. As noted in Section 4a-iv, there are several livestock operations in the watershed.

4e-3d Highly Erodible Land Soils

The NRCS has developed a list of highly erodible soils based on factors such as grain size and composition, and slope. As shown on Figure 4e-6, most of the watershed is designated as "potentially highly erodible." Highly erodible soils are concentrated on the knolls of the kame moraine in the east and the steep-sided valleys in the west.

Section 5a-3 models the sediment yield from erosion within the watershed.

*Note: **Sections 4e-4j and 4e-4k,** dams and petition ditches, were addressed under section 4d.*


Middle Cuyahoga River Watershed
Figure 4e-6
Highly Erodible Land
Highly erodible land
Not highly erodible land
Potentially highly erodible land
Streams and Rivers
Lakes and Ponds
Subwatersheds with 12-digit HUC number
041100020306
Jurisdictions
Main Roads
Sources: NEFCO, 2010; Portage County GIS 2010; Summit County GIS 2009; Stark County Planning Commission 2010; Ohio DNR GIS 2010; SSURGO soil database
Miles
0 0.5 1 2 3 4
N
SUMMIT CO.
PORTAGE CO.
Main Stem/L. Rockwell
041100020203
Twin Lakes
Lake Rockwell
Lake Pippen
Fish Creek
041100020305
Fish Cr.
River
Brady Lake
Wahoo Ditch
Silver Lake
Walnut Cr.
KENT
Middle Cuyahoga
041100020305
Collins Pond
CUYAHOGA FALLS
Middle Cuyahoga
041100020306
AKRON
Kelsey Cr.
Johnson Ditch
Plum Cr.
Brimfield Ditch
Lake Hodgson
Sandy Lake
Muzzy Lake
Reed Ditch
Plum Creek
041100020501
Breakneck Cr.
Hudson Ditch
Breakneck Creek
041100020202
Breakneck Cr.
Mogadore Reservoir
Potter Creek
Cranberry Creek
Randolph Ditch
Congress Lake Outlet
Wingfoot Lake
Potter Creek
041100020201
PORTAGE CO.
STARK CO.
Congress Lake

4e-4 Water Quality Attainment: Status and trends

As noted previously in Section 4d, the greatest water quality improvements have come from removing or altering dams along the main stem and Plum Creek, restoring natural hydrology, improving habitat, and increasing nutrient uptake. The highly developed, altered, and impermeable nature of the subwatersheds and the resulting non-point source pollution and runoff are among the greatest remaining threats to water quality.

In the older urban areas, including Ravenna, Kent, and Cuyahoga Falls, there is potential for ground or surface water contamination from older land uses such as uncapped landfills (Kent) or industrial uses (Ravenna, Cuyahoga Falls).

A new source of concern is the potential for damage from hydraulic fracturing ("fracking") used to drill deep oil and gas wells into the Utica shale. Partners have expressed concern because of the lack of local control over siting oil and gas wells and the potential for contamination between aquifers resulting from imperfect casing practices.

Main Stem

The quality of the main stem has been improving with the removal or alteration of dams, as indicated by increased dissolved oxygen and QHEI and fish scores, with the river generally attaining water quality standards upstream of the former Munroe Falls dam. As remaining dams are removed or altered, this trend is expected to continue.

Fluctuations in dissolved oxygen and slightly elevated phosphorous levels suggest the Middle Cuyahoga River is still somewhat enriched in phosphorous, and nitrogen levels are consistently higher than state targets. Elevated levels of nutrients and bacteria during higher flow suggest the influence of non-point source pollution. The City of Akron's CSO Long Term Control Plan will reduce bacteria levels in the Gorge and downstream. Communities are increasing recreational opportunities along the river. The main stem should be monitored for changes in biological indicators and bacteria levels.

Main Stem tributaries are greatly affected by the imperviousness of the watershed. With excess water flowing through the channels and limited access to floodplain, many of the Main Stem tributaries are incising, which negatively affects habitat by increasing silt cover and embeddedness along the channels and reducing beneficial features such as gravel substrates and floodplain/riparian access.

The City of Cuyahoga Falls public water supply is on the floodplain of the Cuyahoga River. The City is finalizing its wellhead protection plan and owns much of the area over the five-year time of travel zone, which is used as a park. The wellfield is susceptible to surface water influence, as the river is used to recharge the wells.

Fish Creek

The lower portion of Fish Creek was in non-attainment of WWH standards when it was last assessed in 2000. With the removal of the Munroe Falls dam, it is possible that lowering the base level of this tributary has increased velocity enough to improve measured water quality. The lower portion of Fish Creek also exhibits levels of phosphorous and nitrogen in excess of state targets for WWH waters.

The remainder of Fish Creek has been redesignated MWH-C. This portion of the creek met the lower MWH water quality standards in 2000. However, the watershed has developed substantially in the meantime, increasing the loading into the creek and reducing the amount of treatment provided by the landscape. In Portage County, substantial undeveloped areas remain that could conceivably be developed over time and increase the load to the creek. Long-time residents noted that "there used to be fish in Fish Creek," possibly reflecting degradation of the system since the intense development since 1990. Along most of the creek, the channel appears to be embedded and the water turbid.

Plum Creek

The two monitored stations along Plum Creek were in full attainment of WWH standards in 2000. The Tallmadge Rd. site remains in a wooded corridor and appears to have features of an intact stream corridor, including floodplain access, sinuosity, and a wooded riparian corridor. The Cherry Ave. site was downstream of the Plum Creek dam, and with removal of the dam and restoration of habitat upstream of the former dam, this portion of the creek appears to be improved, with positive features such as boulders for cover, access to floodplain, sinuosity, and a gravel substrate. The subwatershed has undergone substantial development in recent years, raising the risks of degradation from non-point source pollution, altered hydrology, and runoff. Recent measurements along Plum Creek suggest that phosphorous levels are elevated compared to state targets. Most of the upstream portions of Plum Creek have been severely channelized and straightened, reducing habitat values in these portions of the creek. Immediately upstream of the restored portion in Plum Creek Park is a large expanse of wetland mosaic, which is partially protected in the Cooperrider preserve.

One major development is adjacent to "Hidden Lake." Stewardship by homeowners would be important here to reduce non-point source pollution.

A golf course is within the Portage County public water supply well field's five-year time of travel. This would be an important location for stewardship and best management practices.

Breakneck Creek

Breakneck Creek offers varied water quality, ranging from attainment along much of the near-pristine sections of the creek to non-attainment of limited resource water in Ravenna. Contributing sources are likewise varied, including non-point source pollution and runoff from developed areas, potential contamination from old industrial sites or landfills, agricultural runoff, and failing septic systems. Hudson, Reed, Brimfield, and Wahoo Ditches have been channelized and exhibit lack of floodplain access, vegetated riparian areas, channel development, and sinuosity. The main stem of Breakneck Creek flows through a largely intact wooded and wetland riparian corridor.

Areas in Brimfield, Ravenna and Rootstown Townships were the most rapidly developing. It is important that development not encroach on the riparian corridor of Breakneck Creek, as it appears that this corridor has buffered the creek from upstream influences. Addressing brownfields is important in the older urban areas. Increased development controls to encourage green infrastructure and protect natural features, stewardship, and best management practices are important in the developing areas. In the agricultural areas, it is important to encourage and increase the use of best management practices.

Lake Hodgson, which occasionally draws water from Congress Lake, has shown elevated chlorophyll counts and taste-odor problems associated with algae blooms. These appear to have increased during recent years. Recent development near the lake may have increased non-point source pollution into Lake Hodgson.

Phosphorous levels in the lower Breakneck Creek were elevated compared to state targets for WWH waters. Phosphorous levels at stations further upstream were occasionally higher than state targets in 2000, when they were measured, but these stations cannot be compared with the more recently sampled station at Summit Road due to the difference in sampling dates.

Potter Creek

Much of Potter Creek remains channelized or recovering, resulting in nearly 30 miles that offer few positive habitat features. The Trares Road site apparently has not changed substantially since sampling in 2000. This site was not limited by habitat but rather, poor fish communities. Reidinger Ditch, Cranberry Creek, and Randolph Ditch have been channelized. In spite of substantial alteration of weltands in agricultural fields, large wetland complexes at the northern portion of Potter Creek offer diverse habitat and help protect the creek from degradation. In measurements during 2000, Potter Creek occasionally exceeded state targets for phosphorous and nitrogen. Land use does not appear to be changing rapidly in this subwatershed.

5. Impairments and Pollution Sources

Previous water quality studies have identified some impairments along the river and tributaries. Observations made while developing this inventory and in the course of other efforts have identified characteristics that are likely to contribute to water quality impairments. Impairments have been described in previous sections and are summarized as follows:

Bacteria and CSOs – Along the Cuyahoga River, Fish Creek, and Potter Creek, bacteria levels have occasionally exceeded state criteria for recreational waters. Four CSOs in the Gorge section of the Cuyahoga River are unpermitted discharges occurring under the NPDES permit for the City of Akron wastewater treatment plant. These contribute to high bacteria levels in the Gorge and downstream, but elevated bacteria levels have also been observed upstream of the Gorge section. Elevated bacteria levels are of concern in the Cuyahoga River, as it is being increasingly used and promoted for recreation. It is worthwhile to determine whether elevated bacteria levels are correlated with certain weather events or water quality characteristics (e.g., high turbidity), so paddlers are aware of the potential risk during certain conditions.

Dam Pools – The 2003 and 2000 TMDLs documented impaired habitat conditions, elevated nutrient levels, and decreased oxygen levels in the dam pools along the river. Three dam pools in Cuyahoga Falls remain. Two dams will be removed in 2012, and the Ohio Edison dam is being evaluated for removal.

Nutrients – The Main stem and all tributaries exceed state nutrient targets to varying degrees. Along the Cuyahoga River, effects of nutrient enrichment are evident in diurnal oxygen swings and somewhat elevated levels. While it appears that nitrogen levels along the Main Stem and Breakneck Creek are likely related to wastewater treatment plants to a degree, they also increase with higher flow, indicating a runoff component. Nuisance algae have been observed in Congress Lake and Lake Hodgson.

Sediment – There are no state standards for sediment loading. However, siltation has been identified as a cause of impairment in the Cuyahoga River, Plum Creek, and Potter Creek. Sediment is a concern downstream in the Shipping Channel and Lake Erie. The 2008 Lake Erie Protection and Restoration Plan notes that 1.1 million tons of sediment is transported each year down the Maumee, Sandusky, Cuyahoga, and Grand Rivers, triple the desired load calculated in the Lake Erie Quality Index as necessary to reduce negative impacts from sediment loading. It should be noted that the Ohio Edison dam has stored sediment for the past 100 years. Before the dam is removed, the sediment will be removed, but the dam will no longer retain sediment from the river upstream. The river below the dam is so turbulent that virtually all sediment not deposited on floodplains will eventually move downstream out of the watershed.

Sediment in the watershed tributaries severely affects the habitat quality, biological communities, and stream channels. Many of the streams at road crossings appear to be embedded, suggesting that sediment input is greater than the ability of the streams to remove it. Embedded conditions are one of the key QHEI factors that can impair habitat quality enough to degrade the biological communities. Sediment also carries nutrients and other toxins with it.

Habitat – Habitat impairments have been documented along the Cuyahoga River in the dam pools, with nearly immediate improvements after restoration of flow. Habitat impairments that have been observed in the watershed include:

- Siltation/embedded substrate
- Poor channel form, lack of sinuosity due to channelization or channel incision
- Lack of vegetated riparian buffer/floodplain access
- Degraded, channelized, or altered wetlands
- Invasive species

Contamination - Wellhead protection, fracking, and the potential for contamination from inadequately sealed dumps and landfills in Kent are concerns related to public water supplies.

Section 7 includes tables for each subwatershed that summarize conditions and impairments, providing the basis for statements of problems, goals, objectives, and actions. Section 5a presents results of pollutant loading models or studies, Section 5b presents habitat and hydrologic concerns, and opportunities for conservation.

5a Pollution Loading

5a-iii Agricultural and other land use Inputs

Background: Agricultural and other Land Use Inputs

Non-point source pollution in the watershed stems from developed land, agricultural runoff, septic systems, and channel erosion due to factors such as excess stormwater, inadequate flood storage, and change in length or slope of stream channels.

Agricultural Inputs

Agricultural use represents 30,000 acres or 30 percent of the watershed as a whole, and 62 percent, 32 percent, and 25 percent of the Potter, Breakneck, and Plum Creek subwatersheds, respectively. As noted above, it can be a major source of sediment. Inorganic phosphorous adheres to sediment, so sediment loading can increase phosphorous levels. Nitrogen and dissolved phosphorous tend to be more mobile in the water and enter from runoff. Best management practices to reduce the loading of nutrients can include:

- Use of cover crops,
- Mulch tillage,
- Conservation tillage,
- No-till,
- Grass buffer strips,
- Timing the application of fertilizers to increase uptake and reduce fertilizer loss through runoff
- Wetlands,
- Riparian buffers planted in shrubs or trees, or
- Functional floodplains and riparian zones.

In areas with milkhouses and large numbers of livestock, nutrients and pathogens can enter the water from milkhouse waste or animal waste. In areas with unrestricted livestock access to streams, the streams can be affected by erosion and sedimentation as well as the pathogens and nutrients from animal waste.

Within the agricultural portions of the watershed, primarily Potter and Breakneck Creek subwatersheds, agricultural producers are using best management practices to varying degrees. Much of the crop land has adequate residue and has been cropped using conservation tillage. Even with good crop rotation and conservation tillage, sheet and rill erosion can contribute up to a ton of sediment per acre to the stream in areas without buffers. Few fields are systematically tiled. In tiled fields, clay soils filter substantial amounts of nutrients before the drainage reaches the tile lines. Surface runoff is a contributing factor to both sediment and nutrients entering the stream. Buffers can help stop sediment and filter surface runoff before it can negatively impact water quality.

Unrestricted livestock access and over grazing are problems in the watershed to some extent contributing to sediment and nutrient load. NRCS staff estimate that 90 percent of streams that pass through grazing lands in the watershed allow livestock unrestricted access to streams.

With the use of fencing and related measures, as well as improved buffers, erosion and non-point source pollution into these streams could be greatly reduced.

Urban Runoff

Runoff from developed landscapes contains a variety of contaminants, including nutrients, sediment, pathogens, toxic metals, petroleum products. Sources of contaminants in urban runoff include fertilizers and pesticides, pet and other animal waste, septic systems, toxins associated with automobiles and industry, and legacy sediments from urban/industrial sites. Runoff from construction sites can be especially high in sediment, as unprotected land is eroded. Recent changes to the National Pollution Discharge Elimination System (NPDES) stormwater permitting are intended to reduce the amount of sediment and other contaminants leaving construction properties.

Eroding roadside ditches also contribute to sediment and nutrients in the watershed. Since these are functioning as headwater streams, they could benefit from the addition of buffers or deeper-rooted vegetation, which would reduce pollutants entering the water and possibly reduce the requirements for ditch maintenance.

Pollutant Load Modeling – STEP-L

The US EPA Region 5 Spreadsheet Tool for Estimating Pollution Loading (STEPL) model was used to estimate non-point source pollutant loadings by subwatershed and land cover type. The model uses the Revised Universal Soil Loss Equation (RUSLE) for general land cover and soil types. For this analysis, CCAP land cover data were used. The model allows inputs for failing septic systems, livestock, agricultural practices, eroding stream channels, and best management practices, but it is only a rough approximation of what is entering the water from the land:

- The model uses many simplifying assumptions regarding pollutant loading (e.g., all agricultural uses contribute the same amount of each material, regardless of conditions or practices, when comparing various land uses).
- The model was developed for use on individual sites to determine relative pollutant load reduction through use of certain techniques.
- Individual use of best management practices is not known.
- It is quite likely that loading of nutrients has changed over the years, as the chemistry and application of fertilizers has changed.
- The categories differ between the model and the CCAP land cover data. For the purposes of modeling, high intensity land cover was assumed to be commercial, institutional, industrial, and multi-family uses; and low-moderate intensity was assumed to be residential.

The STEPL model illustrates relative contributions by subwatershed. It will prove useful in the future as projects are developed to reduce certain pollutants, allowing a before-after comparison and an estimate of pollutant loading reduced.

Findings: Pollutant Load Modeling

Findings: Annual Pollutant Loading

Pollutant Loading by Land Cover Type

Results of the STEP-L modeling are presented in Table 5a-1 for each subwatershed. The model indicates that the pollutant loadings reflect the proportions of land cover, failing septic systems, and stream erosion in each subwatershed.

Sediment - The amount of sediment from urban versus agricultural land cover types reflects the proportions of each land cover type in the subwatersheds. In all subwatersheds, eroding streambanks contribute substantial amounts of sediment.

- Potter Creek contributes the greatest amount of sediment due to the high proportion of agricultural land.
- In the Breakneck Creek subwatershed, agriculture, urban land, and streambank erosion all contribute substantial amounts.
- In the Main Stem subwatershed, eroding streambanks account for more sediment loading than the developed land.
- The Plum Creek subwatershed contributes comparatively low amounts of sediment, equally distributed between land use types and eroding stream banks.
- The Fish Creek subwatershed contributes the least sediment, predominantly from developed land.

Nitrogen/Phosphorous
The models indicate that the predominant sources of nutrients are agricultural use, urban land cover, and failing septic systems. The loading from wastewater treatment plants has not been included in these totals. In developed watersheds (all except Potter), this represents an additional load, especially of nitrogen.

- The Breakneck Creek subwatershed contributes high amounts of nitrogen and phosphorous. Septic systems, developed areas, and agricultural areas contribute approximately equal amounts of nitrogen. Phosphorous loadings are greatest from septic systems.
- The Potter Creek subwatershed contributes the second highest amounts of these nutrients. In this subwatershed, the predominant source of both nutrients is agriculture, but failing septic systems contribute a similar amount of phosphorous as pastureland.
- The Main Stem subwatershed contributes the third-highest amount of nutrients, with urban land contributing the greatest amount of both.
- The Fish Creek subwatershed contributes approximately half of the nutrient load of Breakneck Creek, predominantly from urban uses and septic systems.
- The Plum Creek subwatershed contributes the lowest amounts of nutrients, predominantly from developed land and septic systems.

Given the uncertainties associated with the model, it would be beneficial to conduct a survey of fertilizer use and best practices within all the subwatersheds to better understand the loading of nutrients and sediment.

Table 5a-1 Non-point Source Pollutant Load Main Stem

1. Total load by subwatershed(s)				
Watershed	**N Load (no BMP)**	**P Load (no BMP)**	**BOD Load (no BMP)**	**Sediment Load (no BMP)**
	lb/year	lb/year	lb/year	t/year
W1	53882.2	9391.3	198355.8	2338.2
Total	53882.2	9391.3	198355.8	2338.2

2. Total load by land uses (No BMP)					
Sources	**Acres/ amount**	**N Load (lb/yr)**	**P Load (lb/yr)**	**BOD Load (lb/yr)**	**Sediment Load (t/yr)**
Urban		48,873.38	8,174.58	185,064.27	1,201.27
Cropland		375.88	91.59	776.38	44.37
Pastureland		2,552.12	253.18	8,045.33	62.27
Forest		726.63	350.61	1,761.35	34.52
Feedlots		0.00	0.00	0.00	0.00
User Defined		0.00	0.00	0.00	0.00
Septic		0.00	0.00	0.00	0.00
Gully		0.00	0.00	0.00	0.00
Streambank	8,000 lf x 2 banks x 3.5 ft	1,354.22	521.37	2,708.44	995.75
Groundwater	0	0.00	0.00	0.00	0.00
Total	6,549	53,882.23	9,391.34	198,355.77	2,338.17

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load - Fish Creek

1. Total load by subwatershed(s)

Watershed	Annual Load (no BMP)			
	N	**P**	**BOD**	**Sed.**
	lb	lb	lb	tons
W1	30,765.7	5,810.3	103,301.8	895.5
Total	30,765.7	5,810.3	103,301.8	895.5

2. Total load by land uses (No BMP)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban		23,884.28	3,880.39	80,399.42	611.66
Cropland		1,228.30	314.83	2,529.87	166.34
Pastureland		2,181.30	228.79	6,826.34	65.72
Forest		308.56	147.74	742.98	17.77
Feedlots		0.00	0.00	0.00	0.00
User Defined	0	0.00	0.00	0.00	0.00
Septic	100 failing	3,108.82	1,217.62	12,694.36	0.00
Gully	0	0.00	0.00	0.00	0.00
Streambank	2 banks @ 200 lf eroding	54.40	20.94	108.80	34.00
Groundwater	0	0.00	0.00	0.00	0.00
Total	6,549	30,765.67	5,810.32	103,301.76	895.49

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load Plum Creek

1. Total load by subwatershed(s)				
Watershed	**N Load (no BMP)**	**P Load (no BMP)**	**BOD Load (no BMP)**	**Sediment Load (no BMP)**
	lb/year	lb/year	lb/year	t/year
W1	30774.1	5813.5	103318.5	895.6
Total	30774.1	5813.5	103318.5	895.6

2. Total load by land uses (No BMP)					
Sources	**Acres/ amount**	**N Load (lb/yr)**	**P Load (lb/yr)**	**BOD Load (lb/yr)**	**Sediment Load (t/yr)**
Urban		23,874.08	3,876.31	80,253.37	610.76
Cropland		1,189.20	304.67	2,489.95	160.10
Pastureland		2,181.30	228.79	6,826.34	65.72
Forest		308.56	147.74	742.98	17.77
Feedlots		0.00	0.00	0.00	0.00
User Defined		0.00	0.00	0.00	0.00
Septic		3,108.82	1,217.62	12,694.36	0.00
Gully		0.00	0.00	0.00	0.00
Streambank	2 banks x 1.5' x 2,500 ft	62.79	24.17	125.58	34.13
Groundwater	0	0.00	0.00	0.00	0.00
Total		30,724.76	5,799.31	103,132.58	888.48

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005; CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load Breakneck Creek

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	86616.1	18429.0	287478.8	3693.8
Total	86616.1	18429.0	287478.8	3693.8

2. Total load by land uses (No BMP)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	7,975	32,333.77	5,408.21	122,439.65	794.75
Cropland	3,962	9,381.48	2,237.79	29,276.47	856.80
Pastureland	4,354	19,261.73	1,873.42	60,871.60	432.25
Forest	7,635	1,292.79	625.47	3,141.01	56.85
Feedlots	0	0.00	0.00	0.00	0.00
User Defined	0	0.00	0.00	0.00	0.00
Septic	0	15,544.11	6,088.11	63,471.78	0.00
Gully	0	0.00	0.00	0.00	0.00
Streambank	17,000 lf x 2 banks 1.5' mod 1,000 lf 2 banks 3' severe	614.04	236.41	1,228.08	451.50
Groundwater	0	0.00	0.00	0.00	0.00
Total	6,549	78,427.91	16,469.41	280,428.59	2,592.14

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Table 5a-1 Non-point Source Pollutant Load - Potter Creek

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)
	lb/year	lb/year	lb/year	t/year
W1	77878.3	15651.7	222287.8	4686.8
Total	77878.3	15651.7	222287.8	4686.8

2. Total load by land uses (assumes 75% cultivated fields in reduced till)

Sources	Acres/ amount	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban		7,166.45	1,183.07	24,468.48	193.39
Cropland		16,057.22	3,854.90	49,920.02	1,503.83
Pastureland		29,846.26	2,925.26	94,231.04	692.33
Forest		964.13	465.98	2,340.38	43.71
Feedlots		0.00	0.00	0.00	0.00
User Defined		0.00	0.00	0.00	0.00
Septic		9,326.47	3,652.87	38,083.07	0.00
Gully		0.00	0.00	0.00	0.00
Streambank		435.20	167.55	870.40	320.00
Groundwater		0.00	0.00	0.00	0.00
Total		63,795.72	12,249.63	209,913.38	2,753.26

Sources: STEP-L Model, US EPA; AMATS Land Use coverage, 2005;
CCAP Land Cover data, 2006

Additional Sediment Estimates

The STEP-L pollutant modeling was supplemented with two additional estimates of sediment loading. Both the STEP-L and HIT2 models incorporate the Revised Uniform Soil Loss Equation (RUSLE), but use different modifying assumptions. STEP-L includes modifications for use of best management practices, HIT2 includes the effect of landscape features and topography. All three methods resulted in similar estimates for annual sediment loading, approximately 8,300-9,500 tons per year, in spite of widely varying methods. The two subwatershed-specific models (STEP-L and HIT2) indicated that the Breakneck Creek/Potter Creek watersheds supply the largest amounts of sediment.

University of Akron Ohio Edison Dam Sediment Study

A University of Akron geology student sampled sediment behind the Ohio Edison dam and ^{210}Pb-dated a sediment core to determine the amount of sediment trapped annually behind the dam. While the existing sediment will be removed prior to removal of the dam, the annual deposits represent a new source of sediment loading to the Cuyahoga River downstream once the dam is removed. (K. Mann, unpub. MS theses, 2012). The study demonstrated that

- Sediment loading increased during the middle decades of the 1900s, coinciding with population growth and intense development
- In 2006, approximately 8,300 tons of sediment was deposited in the dam pool. It is likely that some of this resulted from the removal of the Munroe Falls dam.
- Sediment loading increased after removal of the Munroe Falls dam restored flow in the Middle Cuyahoga River
- It appears that increased sediment loading may also be related to intensifying weather patterns
- The loading from the Middle Cuyahoga River watershed, as measured at the Ohio Edison dam pool, represents approximately 5 percent of the loading measured downstream at Independence.
- It appears that the Ohio Edison dam is a relatively efficient sediment trap.

HIT2 Sediment Model

The recently developed sediment loading/sediment reduction model for Great Lakes States, High Impact Targeting (HIT 2) was used to map areas where sediment delivery to streams may be reduced through best management practices. The HIT model demonstrates the importance of landscape features in affecting delivery of sediment to receiving waters. The costs and benefits of several BMPs are presented in Section 6. The HIT2 model uses RUSLE, the Revised Uniform Soil Loss Equation, to determine erosion rates, but also combines it with topography and location relative to streams to model how much sediment is delivered to streams. The high-erosion and high-sedimentation locations are then shown on a map, allowing managers to better identify likely areas of high priority for erosion control. As with any mapping and modeling, these results are to be used as guidelines. Field investigation and an understanding of the practices in use are necessary to determine site-specific conditions. Source: http://35.9.116.206/hit2/about.htm

Table 5a-2 HIT2 Model of Sediment Erosion and Delivery

Subwatershed	HUC	Acres	Sediment Eroded Total(tons/yr)	Sediment Delivered to Streams Total(tons/yr)
Feeder Canal-Breakneck Creek	41100020202	28,804	17,207	2,944
Fish Creek-and Cuyahoga River	41100020305	22,641	9,030	1,634
Lake Rockwell-Cuyahoga River	41100020203	39,215	42,545	6,168*
Plum Creek	41100020301	8,293	3,479	492
Potter Creek-Breakneck Creek	41100020201	21,859	17,893	2,578

*The HIT model develops sediment loading for the entire subwatershed upstream of Breakneck Creek. Only a small portion of the subwatershed is within the Middle Cuyahoga watershed.

As shown in Tables 5a-1 and 5a-2 and Figure 5a-1, the Breakneck Creek and Potter Creek subwatersheds represent the greatest amount of erosion and sediment delivery to the streams. (The portion of the Lake Rockwell-Cuyahoga River subwatershed is so small that most of the erosion and sedimentation occurs upstream of the Lake Rockwell dam.) The model also demonstrates that of the erosion occurring in the watershed, approximately one-seventh of the sediment is likely to be deposited in streams. The rest is deposited on the land downslope of the eroding material.

- In the western subwatersheds, areas with high sediment delivery occur along the steep-walled valley of the Cuyahoga River, along some of the steeper tributaries, along the headwaters of Fish and Plum Creeks, and at the head of Johnson Ditch in Tallmadge.

- In the Breakneck Creek subwatershed, the areas with greatest sediment delivery are scattered among the hummocky landscape. Hudson Ditch, Reed Ditch, Brimfield Ditch, and headwater tributaries of Breakneck Creek are areas where sediment delivery is high.

- In the Potter Creek subwatershed, the effects of the hummocky landscape are again apparent. Portions of most of the tributaries in the watershed are near areas of high sediment delivery.

The HIT2 model incorporates existing land cover into the model of erosion and sediment delivery. However, current conditions may not accurately reflect likelihood of erosion and sedimentation, if the land uses are likely to change. For instance, approximately one-third of the Plum Creek subwatershed is currently wooded, presenting low erosion potential. However, because this area still has many platted but un-built lots, the protective woods are likely to be converted to unprotected lots during construction. This area is very hummocky, increasing the potential of erosion on the steep slopes. In rapidly developing areas, it is important to enforce effective use of BMPs for construction.

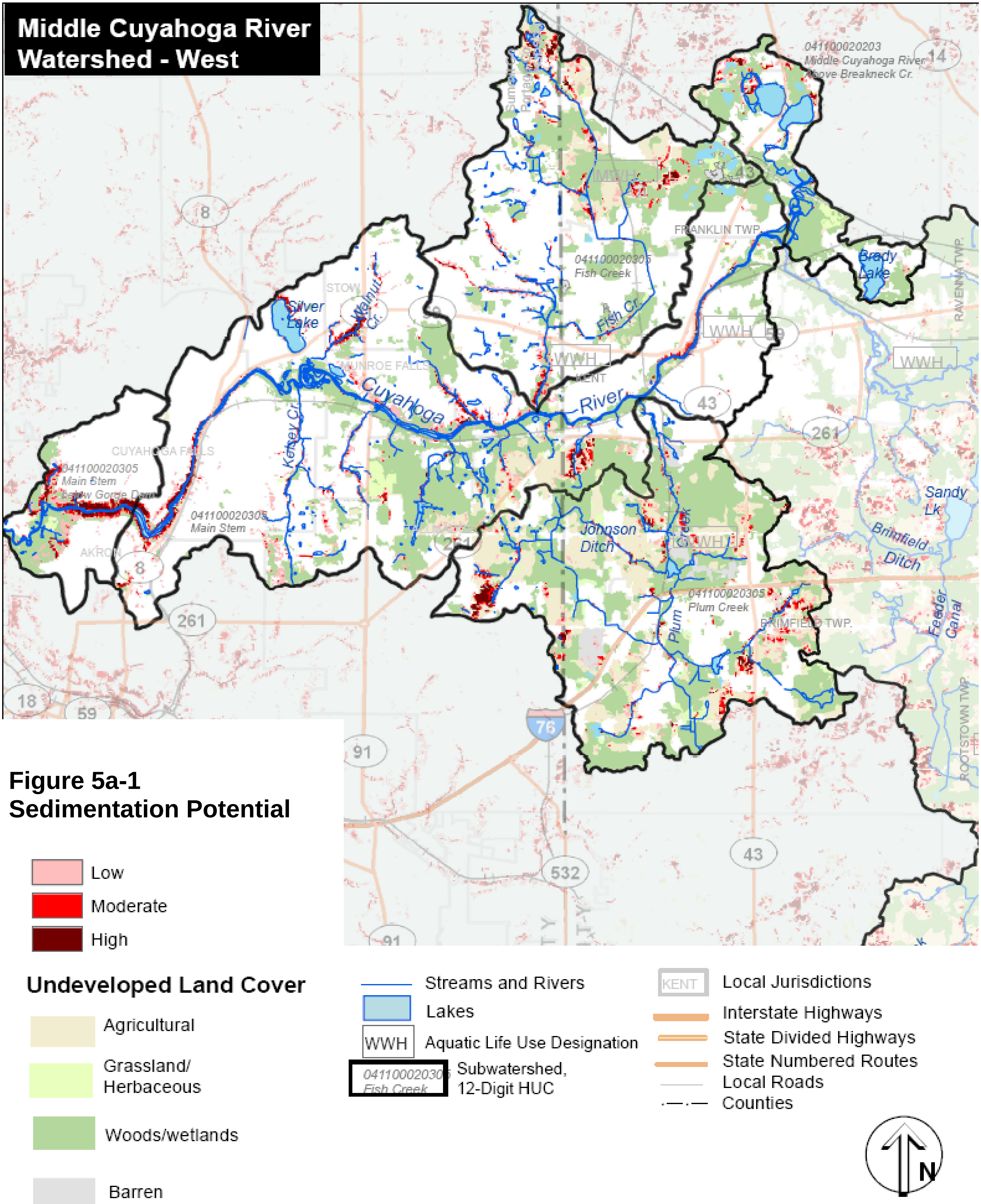
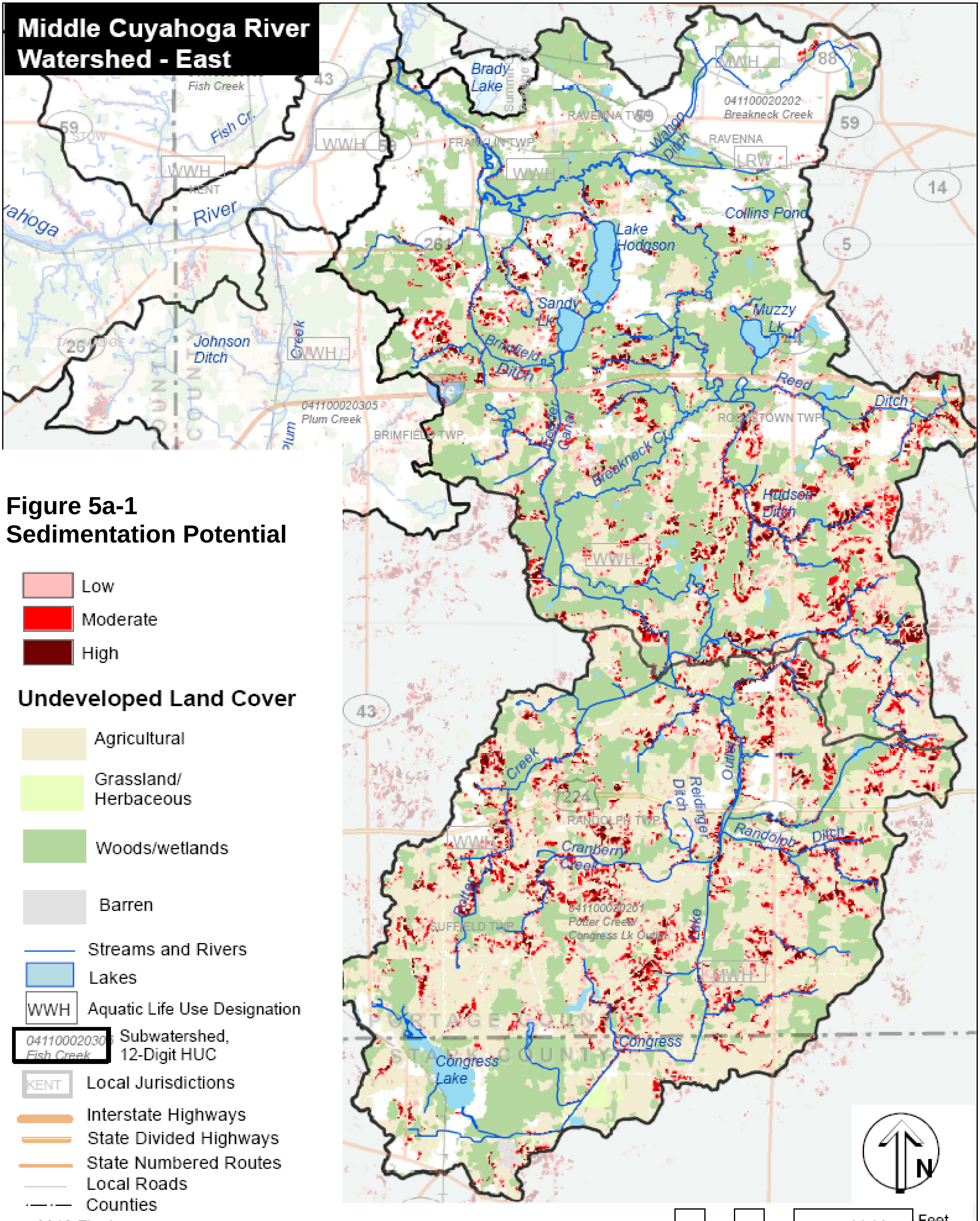


Figure 5a-1
Sedimentation Potential

*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2011. CCAP 2006 Land Cover Data; HIT (High Impact Targeting) Sediment Reduction Model for Great Lakes States

Middle Cuyahoga River Watershed - East



*Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map; 2011. CCAP 2006 Land Cover Data; HIT (High Impact Targeting) Sediment Reduction Model for Great Lakes States

Stormwater Volume, Bank Erosion, Channel Incision – Effects on Sediment and Habitat

Erosion of exposed soil in agricultural and construction sites, while significant, is not the only source of sediment entering watershed streams. A Heidelberg college study of 30 years of water quality data in Lake Erie tributaries (Richards, et al.,2008) indicated that:

- The sediment load of the Cuyahoga River has increased in recent years, and
- The peaks in suspended sediment coincide with the rising limb of storm hydrographs, suggesting that the sediment source is bank erosion from excessive stormwater volume.

As described in Section 4d, net streambank erosion occurs when the load exceeds the capacity of the channel. The additional runoff generated from impervious surfaces often overloads channels. As noted in Section 4a-iv (Land Use), the Middle Cuyahoga River watershed and its subwatersheds are nearly 13 percent impervious as a whole, ranging from nearly 3 percent in the Potter Creek subwatershed to over 26 percent in the urbanized Main Stem subwatershed.

Table 5a-3 compares the volume runoff generated during current conditions versus undeveloped conditions during the ¾ inch storm, the state-specified water quality volume for purposes of stormwater control. Runoff volumes were determined using the formula in the Ohio NPDES General Permit for Construction Activities, which was developed to better represent small storms than the more commonly used TR-55 or Rational Methods. As shown in Table 5a-3, the imperviousness in the subwatersheds has resulted in an increased volume of runoff by 1-1/2 to 5 times the pre-development volumes. Stream channels that developed in equilibrium with an undisturbed landscape could accommodate the flows prior to development. However, with such a significant increase in volume, many of the channels are now severely overloaded, eroding banks as the channel adjusts to the increased volume. Eroding banks of incised streams serves as a sediment source to the tributaries and river, the channels often can no longer access their floodplains, and the tributary habitats are degraded with siltation and poor channel form. In addition, the alteration of wetlands and stream corridor landscapes, and incision of streams below their floodplains, have reduced the ability of the stream corridor landscape to buffer or ameliorate the effects of excess runoff and pollutants. Reduction of imperviousness and improvement of riparian corridor elements are priorities in the watershed.

Table 5a-3 Rainfall Runoff Estimates by Subwatershed - Current and Undeveloped

		Current Condions				Undeveloped Conditions	
	Total	Developed	Undeveloped	Runoff 3/4" Storm		Runoff 3/4" Storm	
Subwatershed	Acres	acres	acres	Cu. Feet	Gallons	Cu. Feet	Gallons
Main Stem	17,813	12,054	5,759	10,267,997	76,804,620	1,939,836	14,509,971
Fish Creek	6,800	4,095	2,705	2,803,230	20,968,161	740,520	5,539,090
Plum Creek	8,292	2,884	5,408	2,527,671	18,906,981	902,999	6,754,431
Breakneck Cr.	28,802	7,975	20,827	8,463,937	63,310,251	3,136,538	23,461,303
Potter Creek	21,857	1,810	20,047	3,434,240	25,688,113	2,380,227	17,804,100

Runoff volume, Q = p x c x a, where p = precipitation (3/4") c is runoff coefficient, $c=.858i^3-.78i^2+.774i+.04$, i = % imperviousness, and a = area, with appropriate conversions from inches to feet. Ohio NPDES General Permit, Long-term analysis of rainfall data indicates that 85% of storm events in Ohio result in a rainfall of 0.50 inches or less. Multiplying this amount by 1.5 (which represents a mid-range regression coefficient for maximizing storm event and volume capture) results in 0.75 being used as the average events. Ohio EPA and the Ohio Department of Natural Resources felt that this was a sufficient precipitation depth to control pollutants in runoff, but also minimize channel and stream bank erosion due to runoff from developed areas. Sources: Stormwater Post-Construction Questions And Answers, http://epa.ohio.gov/dsw/storm/CGPPCQA.aspx#07; Authorization for Discharges Associated with Construction Activity Under the National Pollutant Discharge Elimination System, April 2008, http://www.epa.ohio.gov/LinkClick.aspx?fileticket=y8Ff9MECTVQ%3d&tabid=3466.

The urbanized sub-watersheds and would benefit from green infrastructure (e.g., permeable pavement, rain gardens, biofiltration measures), restoration of riparian vegetation, and other practices to reduce non-point source pollution. Opportunities for green infrastructure demonstration projects include older neighborhoods, redevelopment or enhancement of commercial areas, sidewalks, road rights of way, and public parking lots/buildings.

Streambank erosion from overloaded channels can occur in agricultural landscapes as well as developed ones. Agricultural uses do not create the same degree of imperviousness as development, but the agricultural uses may increase runoff by reducing interception of rain water. Channelizing the streams reduces their capacity to handle flood water, by removing them from floodplains and wetlands, and reducing their length through straightening. In portions of the watershed (e.g., Breakneck Creek headwaters upstream of Congress Lake Outlet) severely eroding banks have been observed in highly channelized stream systems in agricultural areas.

5b-1 Habitat and Hydrologic Concerns - Habitat

Table 5b-1 summarizes known and potential impairments and concerns in the watershed. Problem areas related to land use and channel conditions are shown in Figures 5b-1 and 5b-2. Section 7 (vol. II) includes individual maps and lists of characteristics/concerns for each subwatershed.

As noted in previous sections, the watershed as a whole is characterized by altered habitat. In the urbanized areas of the Main Stem, Fish Creek, and portions of Breakneck and Plum Creek subwatersheds, the alteration is related to development of the area. Tributaries in the rural portions of the watershed, such as portions of Plum Creek, Potter Creek, and Breakneck Creek, have also been altered. Habitat concerns in the watershed include:

- Remaining dam pools along the Cuyahoga River have degraded habitat, excessively silted in, nutrient-rich and oxygen-poor. Two dams will be removed in 2012, and the Ohio Edison dam is being evaluated for removal. Small low-head dams throughout the watershed may impair habitat downstream.
- Incising channels in Main Stem subwatershed – a portion of Kelsey Creek has been assessed as “fair” but degrading. Other tributaries in the Main Stem subwatershed are actively incising, impairing habitat with siltation, embeddedness, poor channel formation, lack of floodplain/riparian access. This subwatershed is 26% impervious, contributing to excessive channel loading.
- Channelized/altered streams, including Wahoo Ditch, Fish Creek, upper portions of Plum Creek, headwaters in urbanized areas, agricultural ditches
- Altered wetlands and riparian corridors, lack of vegetated riparian corridors
- Congress Lake, which is hyper-eutrophic, is at the head of the watershed, feeding Congress Lake Outlet, Breakneck Creek, and occasionally, the Feeder Canal and Lake Hodgson.

In spite of the alteration, the watershed still contains areas that offer important habitat. It is important that these areas not be degraded by encroaching development:

- Intact riparian habitat remains along the Breakneck Creek, lower Plum Creek, and tributaries that are protected by woods and wetlands. Large portions of the riparian corridors not only provide habitat for terrestrial and amphibious species, but also providing important habitat corridors.
- The Cuyahoga River, Breakneck Creek, and portions of Plum (and possibly Fish) Creek offer good quality habitat for aquatic life;
- In some of the undeveloped areas of the watershed, the glacially formed landscape includes numerous wetlands, including rare habitats such as bogs and fens.
- It is important to protect the intact areas from disturbance.

Main Stem

In the remaining dam pools, habitat is likely still degraded, with high proportions of silty substrate and embeddedness, but removal of the remaining three dams would substantially improve the habitat. Tributaries flow through a highly altered landscape. Many exist only as urban drainage. Many of the existing streams are overloaded and incised, degrading the habitat of the tributaries and introducing additional water and sediment to the river. Along the Middle Cuyahoga River and the former dam pool along Kelsey Creek, the woody riparian cover is as yet sparse.

Table 5b-1
Summary of Impairments/Concerns and Causes by Subwatershed

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Main Stem 04110002 0305	Remaining dam pools – degraded habitat due to hydromodification, siltation, lack of sinuosity Restored river/stream sections lack woody vegetation/cover Altered riparian buffer: 60% Altered wetlands: 451 ac Altered/channelized streams: 31 miles	Excessive nutrients and low oxygen in dam pools Nutrients in restored sections still exceed state targets, large diurnal oxygen swings Urban land, eroding streambanks, pasture contributing nutrients – increases during low and high flow 2003 TMDL lists Phosphorous as cause of impairment	Siltation identified as a cause of non-attainment; sediment a concern in the shipping channel and as input to Lake Erie; Beneficial Use Impairment of AOC due to sedimentation	Bacteria levels exceed state standard for recreational waters, predom-inantly in the Gorge section and downstream, due to 4 CSOs 2003 TMDL lists bacteria as non-attainment cause. Elevated bacteria occasionally also UST of Gorge	CF public water supply vulnerable Concerns about fracking 8 sites on DERR list	Highly altered land-scape	Downstream flooding and riverbank erosion are major concerns Imperv. 26%
- Main Stem Tribs	Incision degrades habitat through siltation, poor channel form. Kelsey Creek QHEI 53 = “fair” but degrading due to vertical instability. Riparian buffers: frequently altered – 90-95% of Kelsey & Walnut Creek riparian buffers altered. Eroding streams 4.9 mi Channelized streams 9.7 mi.	Included in above	Incising streams are a sediment source to river, silty substrates degraded habitat			Highly altered land-scape	Localized flooding problems along headwater tributaries – primary concern is eroding channels

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Fish Creek 04110002 0305 (part)	UST of RM 1.3 – channelized, altered/ channelized wetland, lack of riparian buffers North River Rd. – not in attainment due to low QHEI/IBI scores, stressed fish communities from urban runoff/upstream channelization.	Phosphorous exceeds state targets Septic system failure in unincorporated areas Sources (in decreasing order): urban runoff, failing septic systems, ag., eroding streambank	Bank erosion – excessive water, no floodplain access – Spaulding Rd.	Bacteria levels exceed recreational criteria		Potential impacts from develop-ment	Flooding problems Newcomer Rd. and McKinney Ave. area, some headwater tributaries Imperv.: 21%
Plum Creek 04110002 0301	Habitat at monitoring sites appears to be intact At last measurement, stream was in full attainment Removal of dam, stream restoration improved habitat Extensive wetlands at lower end of creek protect quality Upper portion altered Development pressure 12 mi streams channelized 698 ac wetlands altered 51% riparian corridor alt.	Phosphorous exceeds state targets Soils present few areas with severe limitations for septic systems Sources (in decreasing order): urban runoff, septic systems, ag., eroding streambank	Siltation a cause of non-attainment Erosion/sediment from ag fields, unrestricted livestock access, incising stream		Portage County public water supply	Golf course near public water supply Focus for develop-ment	

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Breakneck Cr. 04110002 0201	Habitat largely intact upstream of urbanized area – extensive floodplains, wetlands Invasive species – Brady Lake Headwaters altered/channelized – Hudson, Reed, Brimfield ditches Headwaters incising Channelized – 47.4 mi Altered wetlands 1,739 ac Altered riparian corridor 49%	Nutrient levels exceed state targets Lake Hodgson has nuisance algae/taste/ odor problems Urban runoff, Septic system failures and ag contributing nutrients DO exceedence July 2000 at Summit (4.6 mg/l)	Headwater streams incising Unrestricted livestock access, erosion from ag fields, stream-bank erosion		Kent and Ravenna public water supplies 11 sites on DERR list Fracking a concern	Densely developed northern portion Golf courses	Brimfield Ditch, confluence of Breakneck Cr. & Wahoo ditch, Brady Lake Imperviousness northern portion:
- Feeder Canal	Channelized, attain MWH standards		Eroding banks				
- Wahoo Ditch	Non-attainment – habitat alteration – channelization Embeddedness Urban runoff		Eroding banks		PAHs in sediment exceed probable effects criterion; brownfields and legacy contamin-ants	Highly urbanized	Flooding a concern at trailer park Maintained/ petition ditch

Sub-watershed	Habitat	Nutrients/Oxygen	Sediment	Bacteria	Contamin-ation	Land Use	Flooding
Potter Creek 04110002 0202	Partial attainment – fish communities poor; many portions of creek heavily embedded, silted, channelized, poor channel development; lack of floodplain access, lack of riparian vegetation; some recovering Large wetland complexes in northern portion Streams channelized: 29.5 mi Wetlands altered: 2,585 acres Riparian corridor altered: 79%	Nutrient levels exceed state targets L. Hodgson (downstream), Congress Lake have nuisance algae Agricultural runoff, Failing septic systems,	Potter Creek appears to be silted, embedded Sediment erosion from ag fields and unrestricted livestock access			Agricultural, residential Potential agricultural residential impacts to Cranberry Creek, Reidinger Ditch, Potter Cr.	
- Congress Lake Outlet	Channelized, Riparian buffer largely vegetated	Nutrient levels at uppermost sections exceed state MWH criteria	Incising streams Unrestricted livestock access				

Main Stem, Fish Creek, Plum Creek Subwatersheds

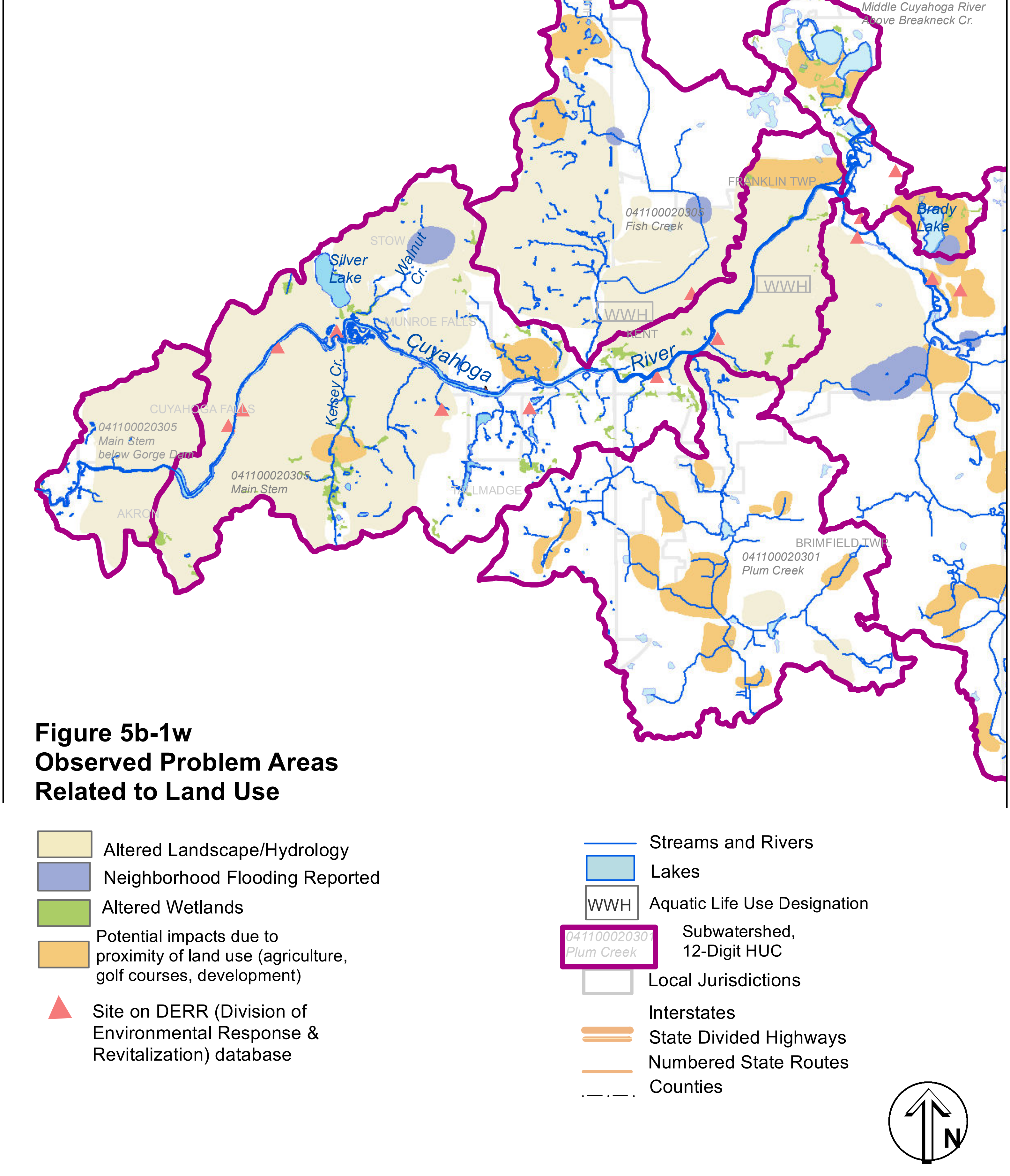


Figure 5b-1w
Observed Problem Areas
Related to Land Use

**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.*

Breakneck Cr., Potter Cr. Subwatersheds

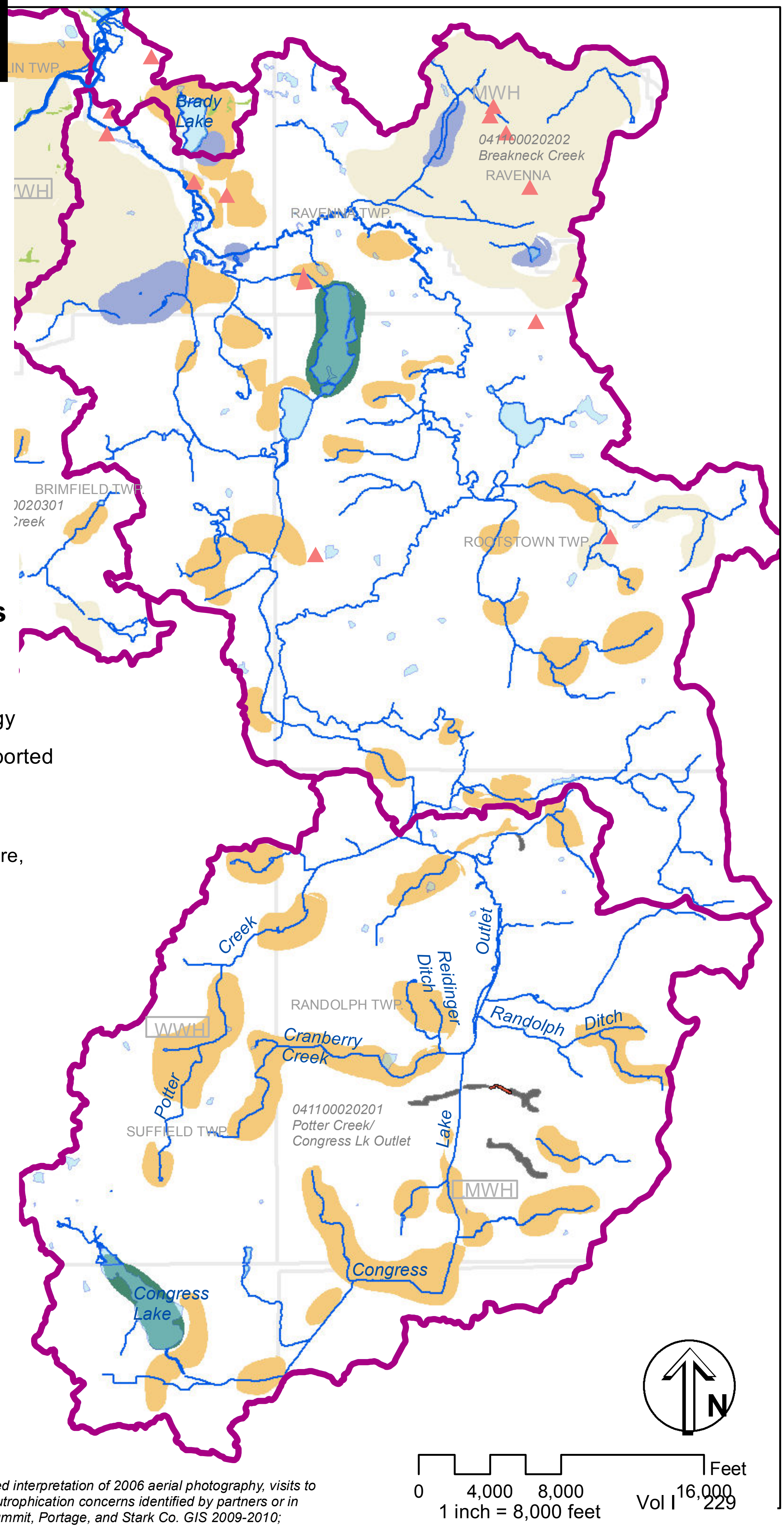


Figure 5b-1e
Observed Problem Areas Related to Land Use

- Altered Landscape/Hydrology
- Neighborhood Flooding Reported
- Altered Wetlands
- Potential impacts due to proximity of land use (agriculture, golf courses, development)
- Nuisance Algae
- Site on DERR (Division of Environmental Response and Revitalization) database
- Streams and Rivers
- Lakes
- WWH Aquatic Life Use Designation
- 041100020201 Potter Creek — Subwatershed, 12-Digit HUC
- Local Jurisdictions

**Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography.*

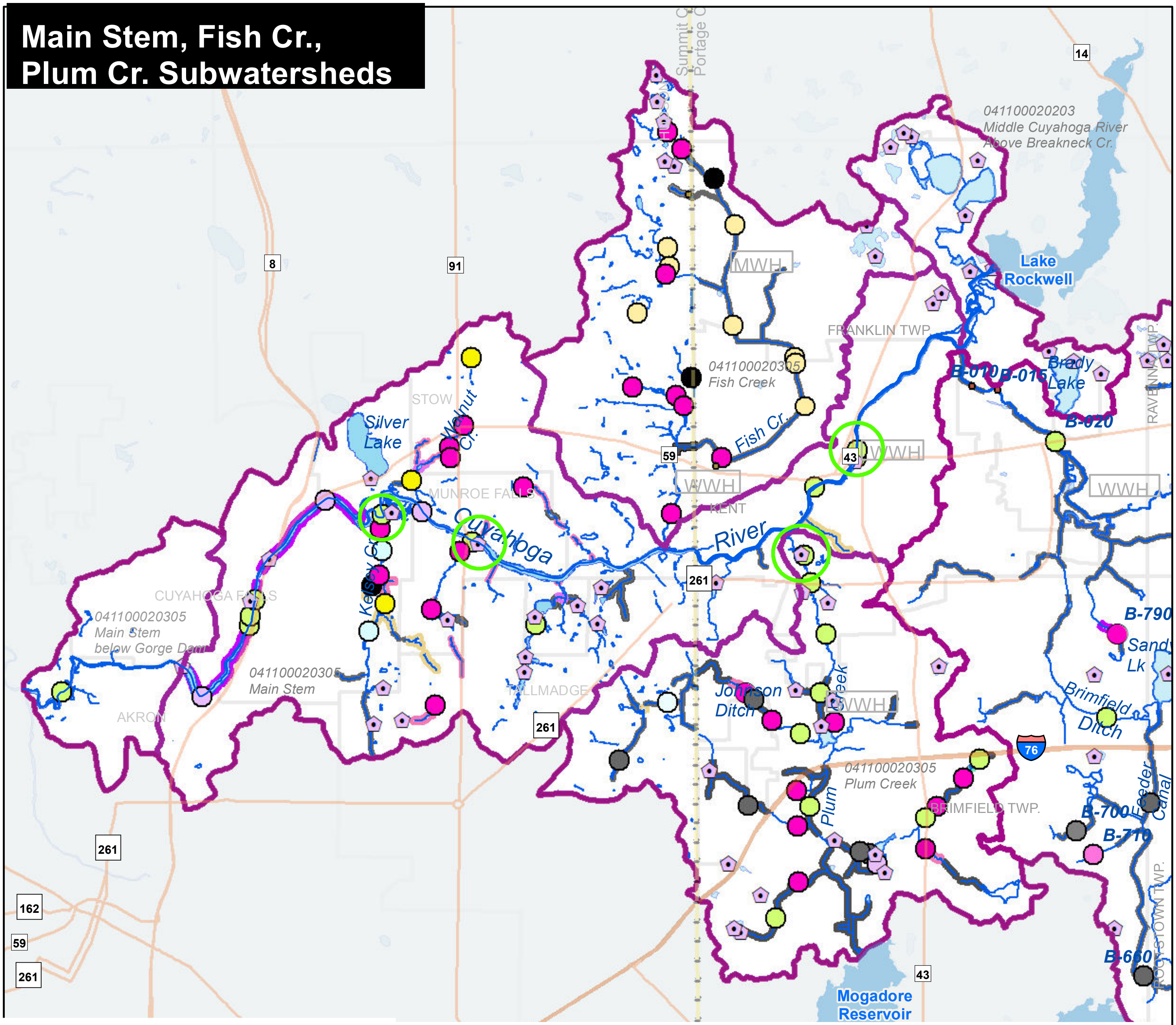


Figure 5b-2w
Observed Problem Areas - Channel Conditions

Channel	At Sites	Condition
		Intact
		Recovering
		Eroding Channel
		Channelized
		Altered
		Impounded
		Dam
		Dam removed/altered between 2004 and 2010

Streams and Rivers

Lakes

WWH Aquatic Life Use Designation

041100020305 Fish Creek — Subwatershed, 12-Digit HUC

Local Jurisdictions

Interstates

State Divided Highways

Numbered State Routes

Counties

N

0 4,000 8,000 16,000 Feet

1 inch = 8,000 feet

*Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography, Ohio DNR dam inventory database 2011.

Breakneck Cr., Potter Cr. Subwatersheds

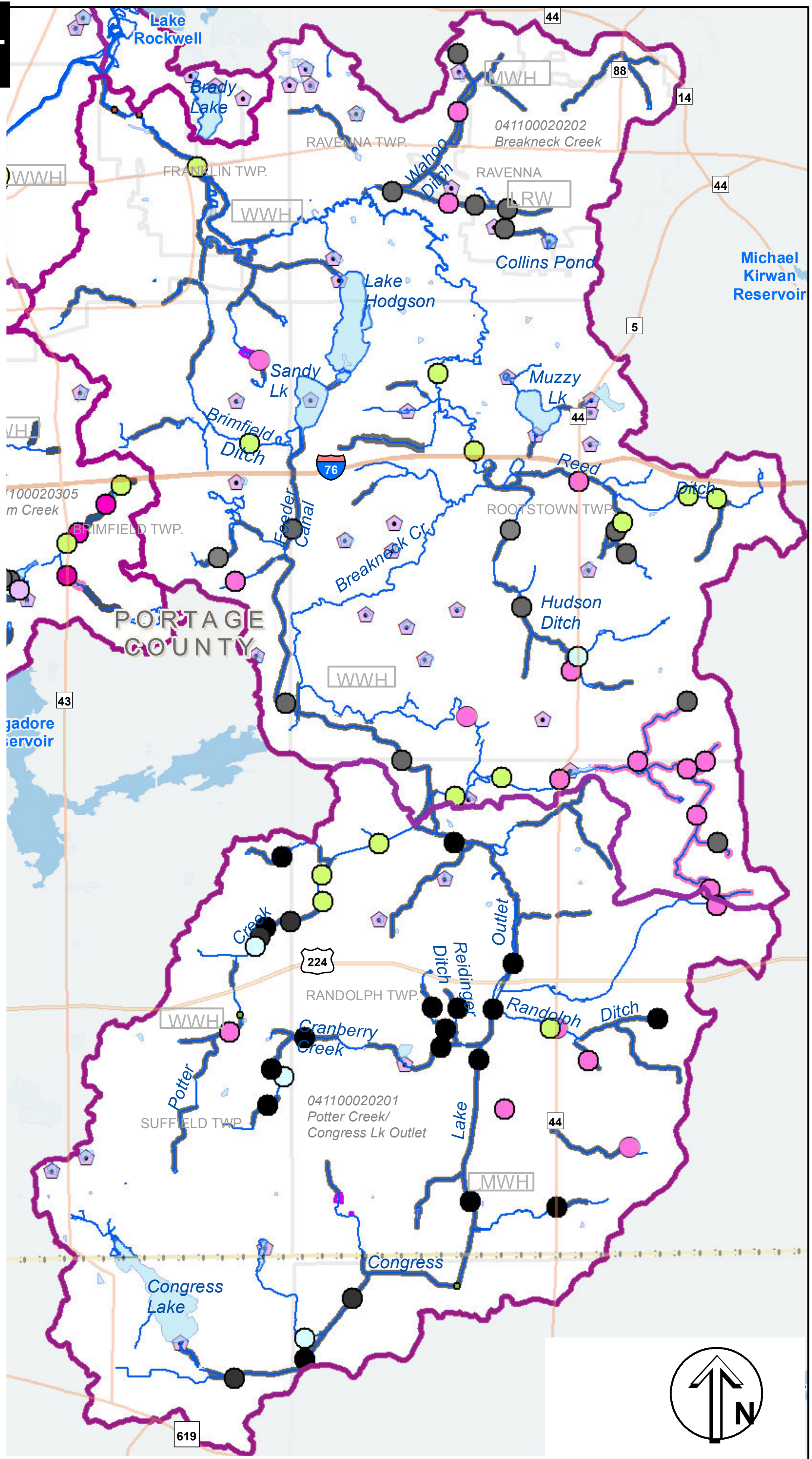


Figure 5b-2e
Observed Problem Areas - Channel Conditions

Channel	At Sites	Condition
		Intact
		Recovering
		Eroding Channel
		Channelized
		Altered
		Impounded
		Dam

Streams and Rivers
Lakes
WWH Aquatic Life Use Designation
041100020201 Potter Creek — Subwatershed, 12-Digit HUC
Local Jurisdictions
Interstates
State Divided Highways
Numbered State Routes
Counties

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

*Problem areas are approximate, identified by limited interpretation of 2006 aerial photography, visits to stream crossings, and flooding, impoundment, or eutrophication concerns identified by partners or in Ohio EPA documents. Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, 2006 OSIP aerial photography, 2011 Ohio DNR dam inventory.

Fish Creek

In the lower 1.3 miles of Fish Creek, still designated WWH, declining QHEI and IBI scores during the 1990s may have reflected water quality declines with rapid development of the watershed during that decade. The recent lowering of the base level of the creek may improve flow in this section of the creek.

Large portions of Fish Creek, now designated MWH-C, flow through altered wetlands in Kent, Franklin Township, and Stow. Because these areas are channelized, they no longer access the wetland or floodplains. While some wooded or shrubby wetlands remain, much of the wetlands appear to be dominated by phragmites. Channel conditions within the altered wetlands appear to be highly embedded. The portions of Fish Creek within Portage County are generally very low-gradient. Prior to development and channelization, it is likely that this, like Breakneck Creek, would have been characterized as a swamp stream. Informal descriptions by Stow officials suggest that the stream channel anastomosed through wetlands in Stow.

Many of the Fish Creek headwater tributaries appear to be largely altered and flow as drainage-ways through residential developments. However, some have protective riparian zones. Drainage ways without protective riparian vegetation might be appropriate for riparian plantings.

Plum Creek

As described further in Section 4d, the lower 4 miles of the creek remains largely intact, flanked by extensive wetlands and floodplains, which likely contribute to the high quality of the stream. Approximately 12 miles of the upper reaches of Plum Creek have been channelized or modified to provide drainage in developed or agricultural areas and exhibit modified characteristics (lack of riparian vegetation, lack of floodplain access, eroding banks, embeddedness, lack of sinuosity). Agricultural fields and unrestricted grazing serve as a source of sediment in the agricultural portions of the watershed, while the developed and developing areas clearly contribute to channel overloading and streambank erosion.

Portions of this modified landscape have been either improved (oversized stormwater basin near Munroe Rd. in Tallmadge replacing a ditch) or left undisturbed (JayCee Park on Howe Ave. in Tallmadge), improving but not entirely restoring the habitat characteristics. Portions of the creek are rapidly eroding and lack riparian vegetation in agricultural areas or golf courses. This subwatershed experienced rapid development between 2000 and 2007, the beginning of a multi-year economic slowdown. Once development begins again, it is likely that this area will again be the focus of growth. It is important to continue monitoring this creek and enforcing and improving upon the use of vegetated setbacks to protect the intact portion of the creek.

Breakneck Creek

As described further in Section 4d several tributaries to Breakneck Creek and the uppermost reaches (above the confluence with Congress Lake Outlet/Potter Creek) are channelized and are influenced by factors such as:

- eroding banks from runoff or agricultural activity, including unrestricted livestock access
- urban runoff
- lack of vegetated riparian buffers, floodplain access, and sinuosity,
- high degree of embeddedness.

Channelized streams include Reed, Hudson, and Brimfield Ditches, as well as portions of Breakneck Creek near the confluence with the Cuyahoga River. The lower portion of the creek appears to be influenced by wastewater treatment plants and the urban landscape.
In the agricultural areas, the headwater habitats become degraded by channel erosion and livestock access. In spite of habitat impairments along the channelized ditches and headwater streams, it appears that the extensive flanking wetlands and floodplains of the middle portion of Breakneck Creek buffer the impacts from the upstream tributaries.

Wahoo Ditch has continually been in non-attainment of MWH-C criteria, with channelization, embeddedness, flow alteration, legacy contaminants, and urban runoff contributing to degraded habitat and biota.

Potter Creek
Potter Creek and its tribuaries are largely altered for agriculture, but there are areas where the creek appears to be recovering. In spite of the high degree of riparian and wetland alteration, but there are two large wetland complexes remaining at the northern end of Potter Creek. Congress Lake Outlet is maintained as a drainage channel, but the riparian buffer along the outlet is largely vegetated.

5b-2 Hydrologic concerns

As noted above, the altered landscape has adversely affected the hydrology of the watershed.

- In the urbanized areas, excess runoff, altered hydrology, and altered riparian landscapes, have resulted in overloading of many streams, especially in the steeply sloping areas. The high volumes are eroding streambanks, causing streams to incise, removing them from their floodplains and exacerbating flooding, streambank erosion, and sedimentation downstream. Evidence of stream channel overloading was also observed at the Breakneck Creek headwaters, many of which are eroding and becoming incised.

- Frequent flooding problems have been noted at several locations, where altered hydrology may have reduced the ability of the streams to handle floods, including: along Fish Creek at Newcomer Road and at several locations along Fish Creek in Kent; Breakneck Creek at Summit Rd.; the mouth of Walnut Creek; headwater tributaries of Walnut Creek; Wahoo Ditch near Route 59; and the margin of Collins Pond.

- Ditching wetlands has reduced the flood-storage ability of portions of the watershed. Wetlands that have been altered and degraded may no longer have the same level of regulatory protection as ones that remain intact.

- Agricultural ditching and channelization/alteration for drainage, has removed tributaries from their floodplains, has resulted in siltation and embedding, and has reduced the ability of the stream network to handle flood events.

- Three dams remain on the Cuyahoga River in Cuyahoga Falls. Numerous small dams are in place at impoundments.

5b-3 Problem Areas and Priorities for Conservation

Problem Areas: Background

Figures 5b-1 and 2 present an overview of problem areas and priorities for conservation, compiled from previous maps. These maps are presented individually for each subwatershed in Section 7, Problems, Goals, Objectives, Actions. They can be used to help direct the actions the partners wish to pursue. They represent a general understanding of watershed problems and preservation potential. However, they do not necessarily represent all the important areas or the highest priorities. Field investigation is necessary before projects can be designed.

Problem areas were mapped using a combination of factors, including:

- Observations from 2006 aerial photographs and limited visits to stream crossings;
- Reports of eutrophication, impoundments, neighborhood flooding, or other concerns;
- Areas where many wetlands have been altered;
- Streams with eroding channels
- Channelized areas;
- Areas where land cover in stream buffers is predominantly agricultural or developed; and
- Areas where the landscape and stream channels have been culverted or severely altered.

The categories shown on Figures 5b-1 and 5b-2, as well as the problem figures in Section 7, are summarized as follows and suggest certain types of actions:

<u>Problem Areas: Land Use Related Concerns</u>

- Altered landscape and hydrology – Stream channels and wetlands have been severely altered by channelization, filling, or development. Field visits are necessary to determine what the opportunities are for each area. Appropriate actions would minimize the effects of development/alteration and restoring function where possible. Examples include: increasing infiltration with green infrastructure, daylighting streams, restoring floodplain access, reconnecting streams with adjacent wetlands/floodplains.
- Potential proximity effects – based on aerial photograph interpretation and limited field visits, it appears that stream channels could be negatively affected by nearby land uses, e.g., developed areas, golf courses, agricultural fields. Site visits are necessary to determine whether the land uses appear to be affecting the water courses/water bodies. Appropriate actions would minimize the negative effects of nearby land uses (e.g., agricultural or urban runoff, erosion), including: restoration of riparian buffer; best management practices to reduce runoff, erosion, sedimentation, and nutrient input (e.g., soil testing, cover crops, grass filters, green infrastructure, Audubon habitat practices for golf courses).
- Altered Wetlands – the presence of hydric soils in altered landscapes suggests that these areas were wetlands that have been altered. In these areas, there may be opportunities for wetland restoration. There may be vacant lands or fields that were once in use but can be restored, or channelized wetlands that could be evaluated for restoration of stream connection/wetland hydrology. Restoration of wetlands, where possible, could help reduce downstream flooding, improve nutrient uptake, and improve/increase habitat.

Areas with hydric soils are more likely to be successfully restored to wetlands than creating wetlands in previously non-hydric environments.

- Areas of problem flooding – While all undisturbed streams flood, flooding becomes a problem when it threatens land use, public safety, and infrastructure. Flooding problems may arise due to altered hydrology or watersheds on-site, upstream, or downstream. Often, specific hydrologic studies are needed to determine the local causes and opportunities to address the problem. Potential actions can include restoration of floodplain access, wetland connection, and channel form, increasing flood storage, and/or reducing inputs through reduction of imperviousness and increasing infiltration (e.g., through downspout disconnect programs, green infrastructure, rain gardens, etc.) on-site or upstream. In some areas, problem flooding results because development is located within a floodplain, and the most effective solution is to remove the development from the floodplain. This necessity has arisen in some of the watershed communities.

Problem Areas – Channel Conditions

- Intact – the channel appears to be connected to a floodplain with a vegetated riparian buffer. This is not a problem area but one that should be protected as is.
- Recovering – the stream appears to have been channelized or otherwise affected but appears to be recovering access to floodplain, sinuosity, form. Actions in these areas might include identification of the previous source of impact, assessment of current floodplain/stream form, protection by a vegetated riparian buffer, and being left alone to recover.
- Channelized – the stream has been straightened, deepened, and no longer has floodplain access. In this type of stream, the habitat has likely been degraded, and the stream probably no longer accommodates flood water or sorts sediments as an undisturbed system would. Because it does not allow flooding, it increases channel erosion locally and increases downstream flooding and channel erosion. Appropriate actions, where practicable, would include restoration of floodplain access or channel morphology and riparian vegetation, if that has been reduced.
- Eroding/incised – the streambanks are eroding more than a system in equilibrium would do so. This degrades habitat and signals other potential sources of problems, such as lack of floodplain access, excessive water, lack of deep-rooted riparian vegetation, change in vertical stability. Appropriate actions would include determining and addressing the cause of erosion and stabilizing the banks, for example:
  - livestock access – provide alternative water supply, restrict access;
  - riparian vegetation – restore deep-rooted riparian vegetation where missing;
  - impervious watershed – downspout disconnect programs, green infrastructure, rain gardens, infiltration practices;
  - change in stream slope – stabilize vertical drop;
  - floodplain access/wetlands – restore watershed features.
- Impounded – observed stream conditions reflect impoundment – still, stagnant water. Appropriate actions, where practicable, would involve removing the impoundment. It should be noted that removing a low-head dam changes the slope of the stream, possibly resulting in stream incision, unless the vertical change is stabilized.
- CSOs – combined sewer outfalls are found in the portion of the Middle Cuyahoga that begins in the Gorge section of Cuyahoga Falls. These result in high amounts of bacteria pathogens and nutrients in the river.

Findings:
General Problem Areas

Generally, the channel conditions in the subwatersheds are as follows:

- Main Stem – This subwatershed is highly impervious and altered. There is a public water supply that should be protected. The Cuyahoga River itself and its riparian area are generally intact. There are some remaining wetlands, some affected by nearby development, some apparently higher quality in wooded areas. The tributaries are predominantly altered and incised, lower portion of the Middle Cuyahoga River is impounded in sections and affected by CSOs.

- Fish Creek – Land use concerns include highly altered and impervious watershed, and large-scale wetland alteration. Fish Creek is channelized upstream of RM 1.4. The tributaries are altered and lack riparian vegetation, some are eroding.
- Plum Creek – Land use concerns include potential impacts to a public water supply, run-off and ereosion along golf courses, agricultural land (runoff, livestock access), and industrial/developed areas. The upper portions of Plum Creek and its tributaries are generally channelized. The lower portion is intact with a substantial wetland/floodplain buffer.
- Breakneck Creek – Land use concerns include the highly altered northern portion; potential brownfields sites; local flooding problem areas; potential impacts from developed areas, a golf course, and agriculture; and the presence of two public water supplies. Channel conditions include intact portions in extensive wetland/floodplain complexes, severely channelized sections (e.g., agricultural/stormwater ditches, Wahoo Ditch), areas with livestock access, and incising channels in headwater areas.
- Potter Creek – Land use concerns are largely related to potential impacts from adjacent agricultural uses. Stream channel conditions include substantial amounts of channelized streams, some severely eroding areas due to upstream influences or livestock access, areas that are recovering, and some that appear largely intact within wetland complexes.

Section 7 includes maps of problem areas and actions specific to each subwatershed.

Priority Areas for Conservation

Priority Conservation Areas: Background

Figure 5b-3 presents an overview of areas identified as high priority for conservation. These represent a general understanding of some of the high value areas to protect. The areas have been identified based on a combination of factors, including:

- Portage County Watershed Plan
- Summit County Comprehensive Plan Environmental section.
- Wellhead and source water protection areas
- Areas with unique species or habitats
- Areas identified as high value in a series of resource protection workshops held by Western Reserve Land Conservancy
- Large wetland complexes
- Wetlands or riparian landscapes that appear to be providing benefit at key locations, e.g., intact riparian corridors, urbanized watersheds, junctures of ditches or eroding tributaries with undisturbed streams.

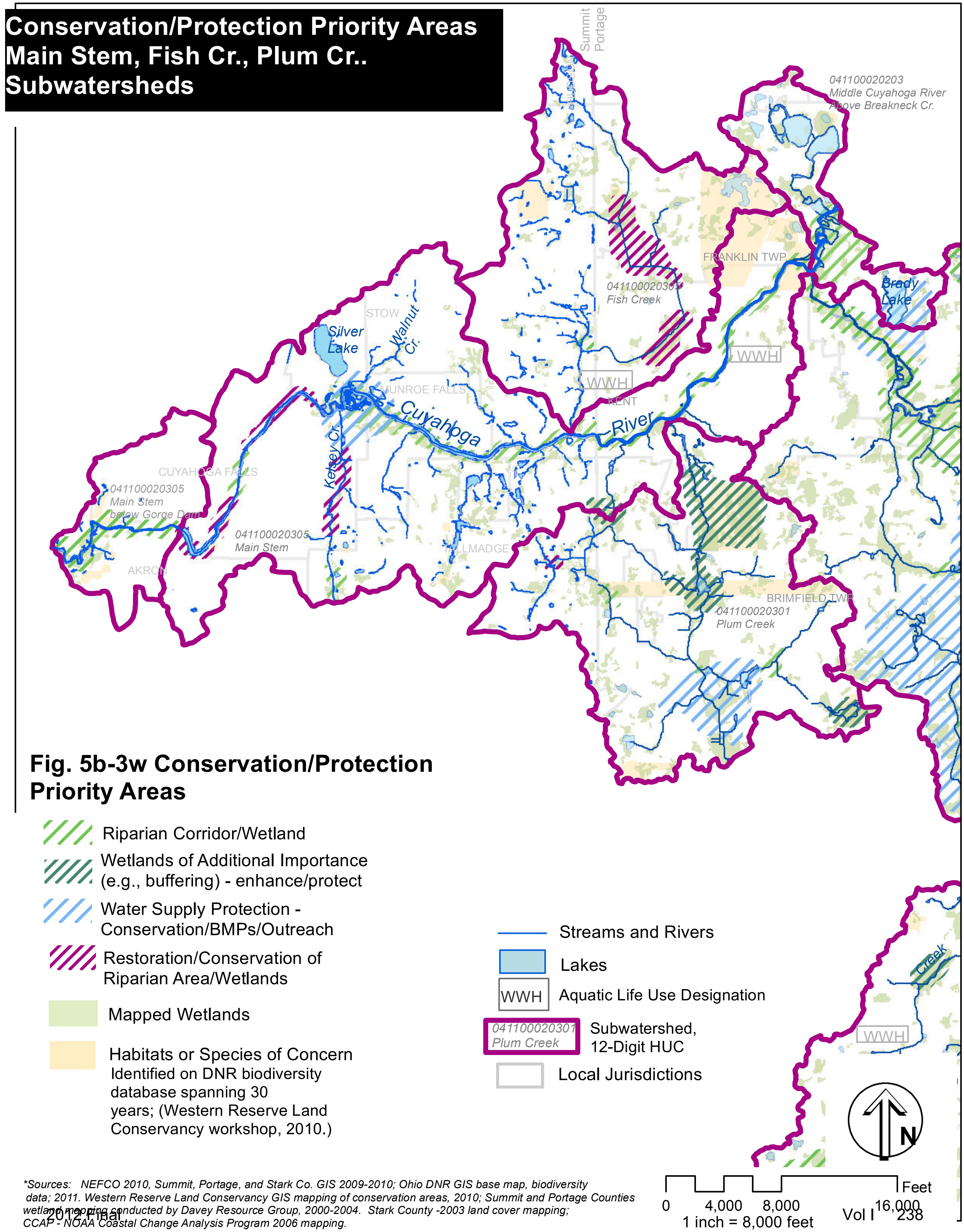
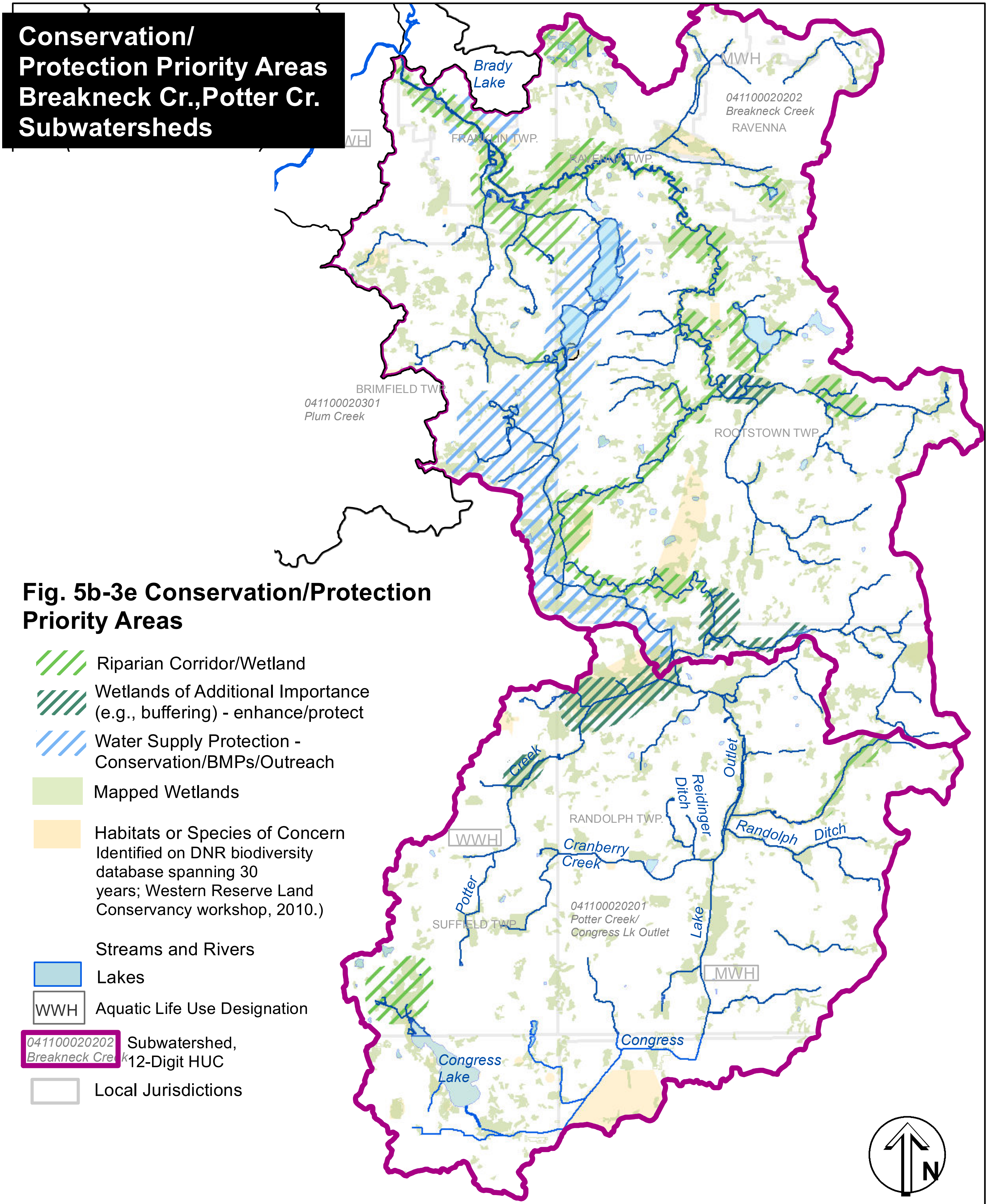


Fig. 5b-3w Conservation/Protection Priority Areas

**Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.*



Sources: NEFCO 2010, Summit, Portage, and Stark Co. GIS 2009-2010; Ohio DNR GIS base map, biodiversity data; 2011. Western Reserve Land Conservancy GIS mapping of conservation areas, 2010; Summit and Portage Counties wetland mapping conducted by Davey Resource Group, 2000-2004. Stark County -2003 land cover mapping; CCAP - NOAA Coastal Change Analysis Program 2006 mapping.

0 4,000 8,000 16,000 Feet
1 inch = 8,000 feet

Areas identified as especially high priority include wellhead protection areas and wetlands that provide additional buffering or habitat benefit. These areas often appear as overlapping shading or hatching, as certain areas provide many valuable functions. There are likely other high priority areas for conservation, as well.

General Findings: Priority Conservation Areas

The high priority conservation areas shown in Figure 5b-3 include riparian areas along Plum and Breakneck Creek, large wetland complexes, remaining wetlands in the Fish Creek subwatershed, wellhead protection areas, and areas containing species or habitats of concern. Tools to protect these include acquisition of land or easements, enhancing or restoring areas that have been degraded to some extent, increasing stewardship, and encouraging best management practices and better riparian management among owners of large parcels. Of special interest is continuing to restore the Cuyahoga River, clean up debris, increase recreational use, increase stewardship and awareness, and establish the river as a river trail.

Section 7 (Vol. II) includes maps of conservation priorities and actions specific to each subwatershed.

6. Implementation Discussion

Chapter 7 includes summaries of concerns related to each subwatershed, problem statements, goals, objectives, and actions.

Development of these statements incorporated partner priorities, consistency with the Lake Erie Management Plan, and implementation considerations, as discussed below.

Partner Priorities

1. Water quality – Restore or improve water quality in impaired areas and degraded systems, prevent further degradation, and protect high quality resources.
2. Hydrology – Reduce the risks of property damage, bank failure, and stream instability due to excessive water volumes, altered stream channel morphology, and altered riparian corridor features such as floodplain access, vegetation, or wetlands.
3. Habitat – Protect and restore important upland, wetland, and riparian habitats, increase biodiversity, protect species of concern, and increase the presence of native species.
4. Recreation – Promote, increase recreational use of the river and tributaries in balance with protecting water quality, well-functioning hydrology, habitat protection, and property owners' rights.

Consistency with Lake Erie Protection and Restoration Plan

The Lake Erie Protection and Restoration Plan sets out a number of goals and objectives for the Lake Erie watershed that are generally consistent with those identified by the watershed partners. The general guidelines for activities within the Lake Erie watershed are excerpted below, and the goals and policies that are applicable to the Middle Cuyahoga River Watershed are summarized after the excerpt. The goals, objectives, and actions that the Middle Cuyahoga River Watershed partners have agreed are priorities support and promote attainment of the goals for Lake Erie.

Activities in the Ohio Lake Erie watershed should:

1. Maximize reinvestment in existing core urban areas, transportation, and infrastructure networks to enhance the economic viability of existing communities.

2. Minimize the conversion of green space and the loss of critical habitat areas, farmland, forest and open spaces.

3. Limit any net increase in the loading of pollutants or transfer of pollution loading from one medium to another.

4. To the extent feasible, protect and restore the natural hydrology of the watershed and flow characteristics of its streams, tributaries and wetlands.

5. Restore the physical habitat and chemical water quality of the watershed to protect and restore diverse and thriving plant and animal communities and preserve our rare and endangered species.

6. Encourage the inclusion of all economic and environmental factors into cost/benefit accounting in land use and development decisions.

7. Avoid development decisions which shift economic benefits or environmental burdens from one location to another.

8. Establish and maintain a safe, efficient and accessible transportation system that integrates highway, rail, air, transit, water and pedestrian networks to foster economic growth and personal travel.

9. Encourage that all new development and redevelopment initiatives address the need to protect and preserve access to historic, cultural and scenic resources.

10. Promote public access to and enjoyment of our natural resources for all Ohioans.

Lake Erie Preservation Plan Goals, Policies, Priorities

- Reduce agricultural sediment input to Lake Erie by 33% from the 2007 baseline.
- Facilitate adoption of (model) regulations regulating stormwater management and requiring riparian and wetland setbacks.
- Apply pesticides and fertilizers more efficiently.
- Re-establish more natural flow regimes in Lake Erie tributaries.

- Protect and restore headwater tributaries.
- Reduce bacterial and other contamination from inadequate or non-functioning home sewage treatment systems.
- Eliminate Combined Sewer Overflows according to each community's Long Term Control Plans.
- Clean up brownfield sites to eliminate loading to Lake Erie and its tributaries.
- Promote diversity of native flora and fauna by protecting and restoring habitat.
- Protect, restore, and enhance wetlands and their functionality and expand wetland acreage within the watershed.
- Protect, enhance, and restore important habitats and species, including…fish spawning areas, caves, riparian and instream habitat in channels and in streams that are subject to impacts from hydromodification.
- Restore habitat through the removal of non-beneficial dams, install fish passages in dams that remain.
- Practice and promote sustainable development practices that protect the natural resources of the Lake Erie Basin and make them available for current and future generations to enjoy.
- Ensure urban areas are sustainable, minimize impacts to the Great Lakes ecosystem, and improve quality of life for residents of watershed communities.
- Responsibly utilize Lake Erie resources and maximize recreational opportunities.
- Preserve and protect valuable farmland for future agricultural uses.
- Reduce significant adverse impacts of repeated flooding on resources, people, and property.
- Identify and address gaps in the green infrastructure system in urban communities within the Lake Erie basin.
- Enhance and increase public access opportunities to Lake Erie, public beaches, parks, nature preserves, and wildlife areas.
- Create new water- and land-based recreational opportunities along or near Lake Erie. Provide a diversity of recreational fishing opportunities for Ohio anglers on Lake Erie and its tributaries.

Implementation Considerations

Many of the proposed actions in this document involve assessing specific sites to determine the degree of intactness or alteration, and to identify which measures could be taken to improve the hydrology, reduce runoff or non-point source pollution, improve flood storage, etc. Before presenting the specific actions, this section discusses some of the general criteria the partners will be using in assessing opportunities for preservation, enhancement, or restoration.

Implementation: Identifying Potential Priority Locations

Implementation: Priorities

Importance of headwaters

The headwaters are the numerous, small, collectors feeding the larger streams. Because they have relatively high amounts of riparian corridor to water volume, the quality, intactness, degree of alteration, and potential for restoration of the headwater riparian corridors play an especially important role in protecting and improving water quality and the functioning of the stream system. Because they all coalesce to form the larger streams, effects to individual headwater streams can be magnified as they join with others that are similarly affected.

Protecting, improving, or restoring altered headwater streams can have a substantial benefit downstream:

- Because headwater streams carry small amounts of water, a relatively narrow buffer can provide tremendous benefit downstream, resulting in less impact to individual properties than further downstream, where wider buffers would be needed to provide similar benefit.

- Infiltrating, intercepting, or storing stormwater in a dispersed way through the headwater areas is a highly efficient and cost-effective way to reduce damaging floods downstream.

- A study by Pappas et al. (2008) indicated that impervious land cover at the headwaters has a greater runoff impact than lower in the watershed, generating three to five times the amount of sediment as imperviousness further downslope. (Source: Pappas et al. , 2008. Impervious Surface Impacts to runoff and sediment discharge under laboratory rainfall simulation. Catena 72 (2008): 146-152; available on-line at sciencedirect.com; www.elsevier.com/locate/catena)

- Many headwaters have been altered, in the urban areas, as road drainage or channelized (or piped) streams; in the rural areas as ditches. Throughout the watershed, headwater riparian corridors have been reduced to mown sod, which offers little or no protection or treatment for streams.

In identifying areas for protection or restoration, the partners will seek opportunities in the headwaters.

Sediment Reduction

Sedimentation is one of the factors degrading many of the stream systems of the watershed. Sediment carries pollutants and is a concern downstream in the Cuyahoga River and shipping channel. Much of the watershed is considered "potentially highly erodible soils."

The HIT2 model, described in Section 5a, estimates how much sediment reduction can be achieved by strategically using best management practices on exposed soil. Table 6-1 presents the type of reduction that can be achieved by installing various practices on the ten percent of the erosion areas that result in the greatest erosion or sediment delivery.

The HIT2 model shows that benefits and costs of the BMPs vary between the subwatersheds. Fish Creek is the most costly in which to prevent both erosion and sediment delivery. In the Potter Creek and Breakneck Creek subwatersheds, the model suggests that best management practices for erosion/sedimentation reduction would be quite effective.

In implementing erosion/sedimentation control measures, the HIT2 model can help identify areas where erosion and sedimentation from exposed soils may be of greatest concern. In these areas, erosion control practices should be applied with care in construction. In agricultural areas, these may be good areas to target for additional best management practices, such as grassed buffer strips, grassed water ways, tillage practices, or riparian corridor restoration.

According to the model, the most effective measure would be to plant grass on the most highly erosive areas. The sediment erosion map can provide some guidance concerning areas of likely erosion/sedimentation. However, the specific application of BMPs depends on a number of factors, including landowner awareness of various practices, cost, how much land would be lost from production, landowner willingness, funding assistance available, and the restrictions that would be placed on the land. The agricultural producers in the watershed currently use a variety of BMPs, with varying degrees of success. The Natural Resources Conservation Service (NRCS) staff conduct numerous field visits to verify site-specific conditions and work with agricultural producers to improve the use of BMPs at each site. NRCS staff have indicated that it would be helpful to survey the agricultural producers in the watershed to determine what practices are currently in use.

Table 6-1 Amount and Cost of Reduced Erosion with Agricultural BMPs

			Mulch Till on Worst 10% of Area				No Till on Worst 10% of Area			
			Total Reduced				Total Reduced			
Name, HUC ending 410002-	Acres	Total tons/yr	tons/yr	%	BMP cost @$10/ ac	BMP cost-Benefit ($/ton red.)	tons/yr	%	BMP cost @ $10/ac	BMP cost-Benefit ($/ton reduced)
Breakneck -0202	28,804	17,207	2,844	17%	$28,804	$10	3,793	22%	$40,326	$11
Fish & Cuy 0305 L	22,641	9,030	286	3%	$22,641	$79	381	4%	$31,697	$83
Rockwell 0203	39,215	42,545	8,242	19%	$39,215	$5	10,989	26%	$54,901	$5
Plum 0203	8,293	3,479	373	11%	$8,293	$22	498	14%	$11,610	$23
Potter 0201	21,859	17,893	3,090	17%	$21,859	$7	4,120	23%	$30,602	$7
Total	120,812	90,154	14,835	13%	$120,812	$8	19,781	18%	$169,136	$9

Name/ HUC ending 410002-	Acres	Total tons/ yr	BMP: Grass on Worst 10% of Area				BMP: 30-ft. Grass Buffer of Ag on all Streams			
			Total Reduced				Total Reduced			
			tons/ yr	%	BMP cost @$10/ ac	BMP cost Benefit ($/ton red.)	tons/yr	%	BMP cost @$10/ ac	BMP cost-Benefit ($/ton reduced)
Breakneck -0202	28,804	17,207	7,822	45%	$126,737	$16	608	4%	$8,836	$15
Fish & Cuy 0305	22,641	9,030	786	9%	$99,620	$127	74	1%	$1,546	$21
L. Rockwell 0203	39,215	42,545	22,665	53%	$172,546	$8	1,058	2%	$13,210	$12
Plum 0203	8,293	3,479	1,027	30%	$36,488	$36	46	1%	$1,438	$31
Potter 0201	21,859	17,893	8,497	47%	$96,179	$11	636	4%	$12,339	$19
Total	120,812	90,154	40,797	37%	$531,570	$13	2,422	2%	$37,369	$15

Table 6-1 (cont'd) Amount and Cost of Reduced Sediment Delivery with BMPs

			Mulch Till on Worst 10% of Area				No Till on Worst 10% of Area			
			Total Reduced				Total Reduced			
Name, HUC ending 410002-	**Acres**	**Total tons/yr**	**tons/yr**	**%**	**BMP cost @$10/ ac**	**BMP cost-Benefit ($/ton red.)**	**tons/yr**	**%**	**BMP cost @ $10/ac**	**BMP cost-Benefit ($/ton reduced)**
Breakneck - 0202	**28,804**	**2,944**	**503**	**17%**	**$28,804**	**$57**	**671**	**23%**	**$40,326**	**$60**
Fish & Cuy 0305	**22,641**	**1,634**	**55**	**3%**	**$22,641**	**$410**	**74**	**5%**	**$31,697**	**$431**
L. Rockwell 0203	**39,215**	**6,168**	**1,246**	**20%**	**$39,215**	**$31**	**1,661**	**27%**	**$54,901**	**$33**
Plum 0203	**8,293**	**492**	**60**	**12%**	**$8,293**	**$139**	**80**	**16%**	**$11,610**	**$146**
Potter 0201	**21,859**	**2,578**	**490**	**19%**	**$21,859**	**$45**	**653**	**25%**	**$30,602**	**$47**
Total	**120,812**	**13,816**	**2,354**	**14%**	**$120,812**	**$51**	**3,139**	**19%**	**$169,136**	**$54**

			Grass on Worst 10% of Area				30-ft. Grass Buffer of Ag on all Streams			
			Total Reduced				Total Reduced			
Name/ HUC ending 410002-	**Acres**	**Total tons/yr**	**tons/yr**	**%**	**BMP cost @$10/ ac**	**BMP cost Benefit ($/ton red.)**	**tons/yr**	**%**	**BMP cost @$10/ ac**	**BMP cost-Benefit ($/ton reduced)**
Breakneck - 0202	**28,804**	**2,944**	**1,384**	**47%**	**$126,737**	**$92**	**307**	**10%**	**$8,836**	**$29**
Fish & Cuy 0305	**22,641**	**1,634**	**152**	**9%**	**$99,620**	**$656**	**35**	**2%**	**$1,546**	**$45**
L. Rockwell 0203	**39,215**	**6,168**	**3,426**	**56%**	**$172,546**	**$50**	**470**	**8%**	**$13,210**	**$28**
Plum 0203	**8,293**	**492**	**164**	**33%**	**$36,488**	**$223**	**25**	**5%**	**$1,438**	**$59**
Potter 0201	**21,859**	**2,578**	**1,346**	**52%**	**$96,179**	**$71**	**294**	**11%**	**$12,339**	**$42**
Total	**120,812**	**13,816**	**6,472**	**39%**	**$531,570**	**$82**	**1,131**	**7%**	**$37,369**	**$33**

High Priorities for Restoration

Some of the areas identified in Figure 5B-1 would likely benefit from restoration of morphology, riparian plantings, floodplain access, or hydrology. Choosing specific sites will depend on site-specific assessment of conditions, landowner and community willingness, feasibility, permitting requirements, and the availability of resources. Additional sites may be identified with further field work or as a result of changes to the landscape.

Within each subwatershed are areas where restoration or improvement of riparian functions would be beneficial:

- Main stem – incised streams – restoration/stabilization if necessary and re-planting mown banks with taller (more deeply-rooted) herbaceous plants, shrubs, or trees;
- Fish Creek – altered wetlands and hydrology; riparian corridors that have been replaced by mown sod – the latter represent an opportunity to prevent damaging channel erosion if addressed early enough;
- Plum Creek – altered channels, streams with unrestricted livestock access;
- Breakneck Creek – channelized streams, ditches; eroding channels at the headwaters; altered wetlands; streams with unrestricted livestock access;
- Potter Creek – channelized streams, ditches, especially where contributing to erosion; altered wetlands; streams with unrestricted livestock access.
- In addition, flooding problems have been reported at several locations throughout the watershed. In each case, it is likely that altered hydrology reducing the capacity of the stream system to handle the flows. Investigation may identify areas where improvements to floodplain access, wetlands, or channel morphology could improve the way the streams function and reduce flooding problems.

When addressing eroding stream channels and problem flooding, it is important to understand and address the cause, which can include lack of floodplain access or wetlands; increased runoff from impervious or even agricultural lands; streambanks with minimal protective vegetation that erode and become incised; or straightening or otherwise steepening the channel.

An additional consideration in restoration is the complexity, size, and connectivity of resource areas. Large, diverse, interconnected systems provide greater benefit for habitat, may be more resilient, and may function better over time. To the extent possible, fragmented systems should be re-connected, and diverse habitat complexes and corridors should be re-established.

Restoration is typically funded through grants, large nearby projects (such as road projects), and local funding sources. However, if suitable sites can be identified, they may provide opportunities for mitigation of impacts under wetland alteration permits, allowing mitigation to occur within the Cuyahoga River watershed instead of elsewhere. One priority of this plan is to continue to develop mapping indicating restoration priority areas and to develop some restoration concept plans to encourage mitigation within the Middle Cuyahoga River watershed.

Restoration or Improvement of Select Watershed Functions

In many cases, full restoration of stream morphology is not feasible or necessary. For instance, in the agricultural areas or those identified on Figure 5B-1 as "Altered," it may not be feasible to fully restore channel morphology. However, there may be great benefit in restoring or improving elements of a riparian system. For example:

- improving plantings, e.g., replacing sod with taller grasses, shrubs, or trees, in altered riparian corridors could help stabilize the stream banks before they start to erode. This would be a more cost-effective approach than conducting a full restoration after erosion takes place.

- It may be possible to improve floodplain/wetland access and remove some floodwater from the channel without full restoration of the channel morphology. This approach could prove more feasible than full restoration at sites like agricultural parcels, or channelized streams within relatively narrow corridors;

- Reducing the load of water into the channels through increasing stormwater interception or infiltration, e.g., through use of rain barrels, bio-infiltration, or permeable pavement in developed areas.

- Improving stormwater treatment in roadway drainage through the use of no-mow grass, vegetated swales, or daylighting enclosed drainage.

- Restoration of wetlands in marginally productive farmed areas,

- Improving conservation practices, riparian buffers, and plantings, on farms, publicly owned, institutional, or homerowners association parcels.

- Encouraging publicly or privately owned golf courses to use practices that lead to Audubon International habitat certification and protect water resources.

In highly developed or agricultural areas, such projects can serve as demonstration and outreach projects, to help watershed citizens better understand their connection to the water. Such projects can begin to incrementally improve watershed function, just as the watersheds were altered incrementally. It may also be possible to improve watershed functions at a large enough scale to make a difference in a nearby water body. For instance, by retrofitting an entire neighborhood with green infrastructure, runoff may be reduced enough to prevent stream channel erosion. Some stormwater utilities offer incentives to install stormwater best management practices, which may help encourage their use.

Importance of Stewardship, Understanding, and Outreach

The primary concerns in the Middle Cuyahoga River Watershed focus on reducing, preventing, and, ultimately, reversing the effects of alteration throughout the watershed. Just as altering the watershed took place incrementally, parcel by parcel, improving conditions will require actions – changes - by many throughout the watershed. Many recommended measures are not especially costly or difficult but require:

- An understanding of how individual parcels affect the watershed,
- A new and different approach to managing the landscape and water, and
- Resources and impetus to put watershed improvement measures into place.

An important part of this watershed management effort will be to increase the understanding among residents, business owners and employees, and local officials, of the benefits to the community of a well-functioning watershed, what they can do to improve watershed conditions, how these measures may differ from previous practices, and what resources are available to assist them in their efforts.

The partners have identified several objectives that focus on the importance of education, information, outreach, and stewardship. These can be the focus of efforts, such as:

- Establishing new tributary stewardship groups, clean-ups, or lake monitoring;
- Increasing the use of best management practices or riparian/native plantings on large parcels (e.g., schools, public buildings, churches, institutions)
- Surveys to determine fertilizer use,
- Watershed photo contests or art events,
- Development of a multi-faceted watershed website, or
- Workshops for officials.

Education also can – and should – be incorporated into restoration, enhancement, and preservation projects. In addition, the educational aspect of all restoration or protection projects is highly valuable. In projects ranging from full stream restoration to improving permeability through rain gardens or permeable pavement, demonstrating that techniques are effective, manageable, and attractive, improves the likelihood that they will be used elsewhere.

High Priorities for Conservation

Figure 5b-3 presents some of the areas that provide important benefits to water quality, flood reduction, and habitat. Many of the areas are wetlands, riparian corridors, and contiguous woods, and perform multiple functions, including buffering, flood storage/reduction, pollutant uptake, habitat, and wildlife corridors. Large, diverse systems and habitat corridors are especially valuable. Figure 5b-2 is a starting point for identifying key areas to protect. It is likely over time that additional sites will be identified as important. One of the priorities of this plan is to continue to develop a map of priority conservation areas with input from various resource managers.

Continued Collaboration

Numerous groups and efforts are underway that can improve conditions in the watershed. The partners wish to continue collaborating with other groups that are pursuing similar interests.

Implementation: Proposed Actions

Development of Priority Actions

Identifying the priority actions has involved several iterations of discussion:

- Throughout the months of developing problem statements, goals and policies, and actions, partners brainstormed ideas that would be helpful in the watershed.
- The watershed coordinator gave presentations to or held meetings with officials from the Cities of Kent, Munroe Falls, Cuyahoga Falls, and Ravenna city officials, Kent Environmental Council, Kent State University biology department faculty, Portage and Summit County stormwater PIPE/task force groups, and NEFCO's Environmental Resource Technical Advisory Committee. Potential actions were discussed at each of these.
- The proposed problem statements, goals and policies, and list of actions was e-mailed to over 100 people in various organizations, with requests for comments.
- Over a period of many weeks and months, the partners who attended monthly meetings reviewed the proposed actions within each watershed, prioritizing them in the process.
- During review of this draft document, the Watershed Coordinator will contact other communities and organizations that have not been regular participants at the meetings to determine what measures they are interested in pursuing, in addition to the actions identified here.

These actions represent measures that the partners who attended the meetings wish to undertake and are comfortable pursuing, contingent on availability of funding, staff, suitable sites, landowner cooperation, and a favorable permitting environment. Some initial suggestions were given a lower priority based on perceived need or feasibility, including survey of residents concerning use of lawn chemicals, discouraging waterfowl or waterfowl feeders, and creating a volunteer clearinghouse with equipment, training, and listings of opportunities. However, the partners would welcome the opportunity to implement these or other actions that promote the goals and objectives identified in Section 7, should the opportunity arise with adequate funding, permitting feasibility, landowner cooperation, etc. The partners also welcome the opportunity to achieve more than listed in the tables in vol. II. This WAP will be periodically updated and amended to reflect newly identified needs, opportunities, and priorities.

Funding Strategy

The partners identified many actions that they are initiating on a small scale already and anticipate continuing, using funding from various sources. To an extent, combining efforts will increase efficiency of project implementation. However, to achieve many of the larger scale objectives (e.g., stream restoration), the partners will need outside funding.

The watershed coordinator anticipates assisting partners with grant proposal writing. With no guaranteed source of funding as yet, the watershed coordinator will begin implementation by seeking outside funding for the position or specific projects, which will allow the partners and the coordinator to achieve some successes, solidify the partnership, and revisit the funding strategies over time.

Consistency with Coastal Non-Point Source Plan

One of the requirements of this plan is that it be consistent with the Ohio Coastal Non-point Source Plan. As this WAP focuses largely on non-point source pollution in the watershed, the goals, objectives, and actions listed in Vol. II help promote the policies in the Non-point Source Plan, as noted in Table 6-2.

The actions identified in this plan are voluntary. The watershed partnership can help implement the coastal non-point source plan by initiating on-the-ground projects to improve conditions or preserve important resource areas, where landowners and communities/agencies are willing, obtaining funding, conducting education and outreach to encourage reviewers to protect watershed features.

Certain of the coastal non-point source requirements fall under the jurisdiction of existing programs.

- All but two of the communities covered by the watershed plan are Stormwater Phase II communities. One of the communities not covered by Stormwater Phase II requirements is within the Portage County stormwater management district. The partners generally have expressed interest in encouraging development that minimizes impacts to water resources. The plan includes outreach, workshops, demonstration projects, and review/updating of local codes to encourage the use of green infrastructure and best management practices. The coordinator will continue to work with County and City engineers and planners, and the three Soil and Water Conservation Districts to facilitate practices that reduce non-point source pollution from development and roadways.
- Stream diversion, and impacts to wetlands and water courses fall under the jurisdiction of Ohio EPA.
- Septic system siting and maintenance fall under the jurisdiction of the Health Departments, all of which have inspection programs and require consideration of soils characteristics in siting septic system.

Table 6-2 Consistency with Ohio Non-Point Source Plan

Ohio Non-Point Source Plan	**Middle Cuyahoga River WAP**	**Watershed(s)**	**Problem Statements/ Goals/Objectives (see Sect. 7)**
Grazing management	Installation of fencing, watering measures, crossings, survey of BMPs and use of additional BMPs/outreach as necessary.	Fish, Plum, Breakneck, Potter	Sediment, N, P habitat
Irrigation water management	n/a		
Watershed management	Outreach to encourage use of riparian setbacks, green infrastructure. Demonstration projects to plant streambanks and riparian corridor. Stream/ floodplain/wetland restoration and preservation goals. Survey and assistance with agricultural BMPs.	All	Sediment, nitrogen, phosphorous, flooding, habitat
Site development	Encourage use of green codes, riparian setbacks, education/ outreach. Most communities are required to comply with NPDES MS4 stormwater permits, which also addresses site development.	All	Sediment, nitrogen, phosphorous, flooding, habitat
On-site disposal systems	County health depts require septic systems to be engineered based on soils characteristics. Receiving waters are not nitrogen limited.	All subwatersheds except Main Stem have septic sytems	Nitrogen/ phosphorous
Operating on-site disposal systems	County health depts are inspecting septic systems and seeking correction. Water bodies are not nitrogen limited.	A concern in all watersheds except Main Stem	Nitrogen/ phosphorous
Local roads	Siting not addressed in plan but does require permitting at state level if wetlands/water courses are involved. WC to coordinate on permit reviews. Proposed demonstration projects address existing drainage and increase infiltration/treatment; code review and workshops to address/ increase use of green infrastructure.	All	Sediment, nitrogen, phosphorous, flooding
Channelization/ channel modification	Plan includes restoration of riparian, vegetation, channel, banks, floodplain, wetlands, potential for daylighting streams, and modification to two-stage/overwide. Stream diversion review is under the jurisdiction of Ohio EPA.	All	Sediment, nitrogen, phosphorous, flooding, habitat
Dams	Plan includes removal of 3 dams, as well as channel/ riparian restoration and feasibility study for removal of small low-head dams	Dam removal – Main Stem; feas. study – all	Dams, habitat
Eroding streambank	Plan includes stabilizing/restoring streambank, vertical stability	All watersheds	Sed., N, P, flooding, habitat

End of Volume 1, Middle Cuyahoga River Watershed Action Plan