



**CHAGRIN
RIVER
WATERSHED
PARTNERS**

Nine-Element Nonpoint Source Implementation Strategic Plan (NPS-IS Plan)

Chagrin River: East Branch Chagrin River HUC-12
(04110003-04-01)

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Chagrin River Watershed Partners, Inc., would like to thank the many partners who helped to compile the information, maps and projects needed to create this document. This NPS-IS plan will help direct projects to efficiently address the nonpoint source impairments in the East Branch-Chagrin River HUC-12 of the Chagrin River watershed.

This plan is based on the *Chagrin River Watershed Action Plan* (2011); all stakeholders that contributed to that plan also assisted with development of this NPS-IS plan. Those organizations include: Ohio EPA, Portage Soil and Water Conservation District, Portage Park District, Cleveland Metroparks, Holden Arboretum, Lake County General Health District, Geauga Park District, Western Reserve Land Conservancy, Camp, Dresser, McKee, Portage County Health Department, Gates Mills Land Conservancy, Lake County Soil and Water Conservation District, ODNR Scenic River Program, Cuyahoga County Soil and Water Conservation District, Geauga County Soil and Water Conservation District, Lake Metroparks, Geauga County General Health District, and Case Western Reserve University. Additionally, CRWP Members (Auburn, Aurora, Bainbridge, Bentleyville, Chagrin Falls City, Chagrin Falls Township, Chardon City, Chardon Township, Eastlake, Gates Mills, Hunting Valley, Kirtland, Kirtland Hills, Mantua Township, Mayfield Village, Mayfield Heights, Mentor, Moreland Hills, Munson, Newbury, Orange Village, Pepper Pike, Russell, Solon, South Russell, Waite Hill, Wickliffe, Willoughby, Willoughby Hills, Woodmere, Cleveland Metroparks, Geauga Park District, Lake Metroparks, Lake County) and At-Large Directors contributed valuable input at a December 8, 2016 Board of Directors meeting and through an online survey.

Chapter 1: Introduction

The East Branch of the Chagrin River is represented by 12 digit HUC 04110003-04-01 and encompasses the East Branch Chagrin River and all of its tributaries. The East Branch drains 51.33 square miles and joins the Chagrin River at river mile 4.98. This subwatershed includes portions of northwestern Geauga County and southwestern Lake County in Ohio. Tributaries included in this HUC-12 include Quarry Creek, Stoney Brook, Pierson Creek, Baldwin Creek/Shadybrook, Mt. Glen Tributary/Unnamed Tributary (RM 10.13), Stebbins Gulch, Harris Creek/Unnamed Tributary (RM 14.62), and several unnamed tributaries.

State and Federal nonpoint source funding is now closely tied to strategic implementation-based planning that meets U.S. EPA's nine minimum elements of a watershed plan for impaired waters. Chagrin River Watershed Partners, Inc. (CRWP) have taken the lead in authoring this NPS-IS with input and collaboration from our watershed Member communities, park districts, and other local agencies and conservation organizations. All the stakeholders have agreed to collaborate toward the development of Nine-Element Nonpoint Source Implementation Strategic Plans for every HUC-12 watershed in the Chagrin watershed. A total of seven, one for each HUC-12 unit, will be developed for the Chagrin River watershed.

1.1 Report Background

This NPS-IS Plan was created as an update to the *Chagrin River Watershed Action Plan* (Chagrin WAP, 2006; updated 2010, revised 2011). The Chagrin WAP was financed in part or totally through grants from the Ohio Environmental Protection Agency and the United States Environmental Protection Agency, under the provisions of Section 319(h) of the Clean Water Act. It represents a collaborative effort to improve local land use planning and water quality throughout the Chagrin watershed and balance the development and conservation priorities of our watershed communities and park districts. The *Plan* incorporated recommendations and action steps from the *Chagrin River Watershed TMDL Study* (Ohio EPA, 2007).

The Chagrin WAP was adopted by the Chagrin River Watershed Board of Directors (formerly Board of Trustees), which represents local governments and park districts in the Chagrin River watershed. This plan was fully endorsed by the Ohio Environmental Protection Agency and Ohio Department of Natural Resources on December 18, 2006. The WAP was revised in December 2009 and submitted to Ohio Environmental Protection Agency and Ohio Department of Natural Resources on January 15, 2010. CRWP completed WAP updates in September 2011 to provide additional details on subwatersheds in non-attainment of water quality standards. For more details on the initial watershed plan development process, please reference *Chapter 2: Watershed Plan Development* in the Chagrin WAP, found online at <http://crwp.org/index.php/projects/watershed-plans>.

With the change of program focus, this NPS-IS Plan is being created to guide our watershed communities in addressing nonpoint source pollution issues specifically for the East Branch-Chagrin River (04110003 04 01), rather than a watershed plan for all issues in the Chagrin watershed. CRWP and its Members expect to create NPS-IS documents for all seven HUC-12 watersheds with the Chagrin River watershed. CRWP will continue to update the Chagrin WAP with other information or actions to address other impairments with the goal of restoring and maintaining water quality standards in the Chagrin's HUC-12s.

1.2 Watershed Profile & History

The Chagrin River has its headwaters in the Beaver Creek-Chagrin River HUC-12 in the City of Chardon in Geauga County, Ohio. The river flows from an origin elevation of 1,326 feet approximately 24.7 miles southwest over an average fall of 20.4 feet/mile to an elevation of 822 feet to the confluence of the Chagrin mainstem with the Aurora Branch in the Village of Bentleyville in Cuyahoga County, where it then flows 27.5 miles to the north over an average fall of 9 feet/mile to Lake Erie in the City of Eastlake (approximate elevation 572 feet).

On a 1755 map, the Chagrin River was labeled as the Elk River. The name "Chagrin" has been claimed to come from two different sources. One source claims that the river name "Shaguin" memorialized a French trader

named Sieur de Saguin. Another hypothesis is that the name came from the Indian word “shagrin” meaning “clear water.” Regardless of the origin of the name, it was anglicized in 1797 on a map of the Western Reserve prepared by Seth Pease to read “Chagrin River.” Land use has been changing in the Chagrin River valley since the settlers first arrived in the 1700s. These families cleared forests and drained wetlands to build farms and villages, and the Chagrin River was used for mills in these early days. Despite massive clearing and agricultural, residential, commercial and industrial development, the Chagrin River maintains high water quality and natural beauty in many locations.

Seventy-one miles of the Chagrin River have been designated as a State Scenic River. The original designation of 49 miles includes the Aurora Branch from S.R. 82, 12 miles downstream to its confluence with the main stem of the Chagrin, 23 miles of the main stem from its confluence with the Aurora Branch downstream to US Rt. 6, and 15 miles of the East Branch from Heath Road Bridge downstream to its confluence with the main stem was made in 1979. The river’s Scenic designation was extended in November 2002 to include the headwaters of the Chagrin, also known as the Upper Main Branch of the Chagrin, from the Woodiebrook Road bridge to the confluence with the Aurora Branch of the Chagrin River in Bentleyville. Scenic designated reaches of the river are characterized by exceptional aquatic habitat and adjacent high quality forests.



Figure 1: Scenic River designations in the Chagrin River watershed (highlighted in yellow)

Glacial activity shaped the watershed with resulting soils and geologic deposits contributing to the high quality and varied habitats of the watershed. Since the last glaciers retreated approximately 12,000 years ago, the river has progressed from the upland headwater areas to create deep ravines further downstream. There are many areas on the Chagrin River and its numerous tributaries where thick glacial till has eroded, exposing sandstone and Chagrin Shale bedrock. The Chagrin River watershed lies in two distinct physiographic regions: the glaciated Allegheny Plateau and the Erie Lake plain. Soils with clayey textures in the subsoil that formed in glacial till predominate in the watershed, and somewhat poorly drained soils are common in areas with six percent slope or less.

The geology of the Chagrin River watershed creates numerous issues for watershed management and land development including: erosion, stormwater runoff, and septic suitability. Rapid runoff and erosion are significant concerns through much of the watershed because of the proximity of bedrock to the surface, the instability of the glacial deposits, and the steepness of the valley areas. The geologic factors that affect the operation of septic tanks include the permeability of the soil, depth to bedrock, depth to the water table, slope, and drainage. Soils in the Chagrin River watershed are generally of limited use for proper sewage disposal in many communities because of their low permeability and seasonal high water tables.

The terrain of most of the watershed is generally rolling with a substantial percentage of wooded land. The Chagrin River is deeply entrenched over the lower 25 miles of its length and flows on bedrock in narrow valleys through much of the watershed. The glacial deposits in the watershed overlay sandstone and shale bedrock. Bedrock is deeper than 60 inches below the soil surface in most of the watershed, but it is 20 to 40 inches below the soil surface in some nearly level or gently sloping areas. The major geologic deposits obvious in the watershed are the uppermost Sharon Conglomerate, that provides rock outcroppings and ground water input in reaches of the Upper Main and East Branches of the Chagrin River and formations of Berea Sandstone and Shale outcroppings of both Cleveland and Chagrin Shale in the lower reaches of the river.

The climatic system that influences the weather in the Chagrin River watershed is known as humid continental, typified by cold and snowy winters and hot and humid summers. Average daily temperatures in the winter range from slightly below freezing in the winter months to the high 60s to low 70s during the summer months. Precipitation ranges from 40 to 47 inches per year on average. Due to the proximity to Lake Erie, average annual snowfall in the watershed ranges from 70-100 inches. Despite the significant snowfall, 50-60% of the watershed's precipitation occurs between April and September.

The Chagrin River watershed drains 267 square miles in four Northeast Ohio counties: Cuyahoga, Geauga, Lake, and Portage. Portions of twenty-two municipalities, ten townships, and four park districts govern land use and other activities in the watershed. The Main Branch of the Chagrin River begins above Bass Lake in the City of Chardon and flows 48 miles before entering Lake Erie in the City of Eastlake. Along its path, the Main Branch is joined by the Aurora Branch, flowing from the Mantua Township and Aurora and meeting the Main Branch in Bentleyville, and the East Branch, beginning in Geauga County and joining the Main Branch in Willoughby. The Chagrin River watershed has seven HUC-12 subwatersheds.

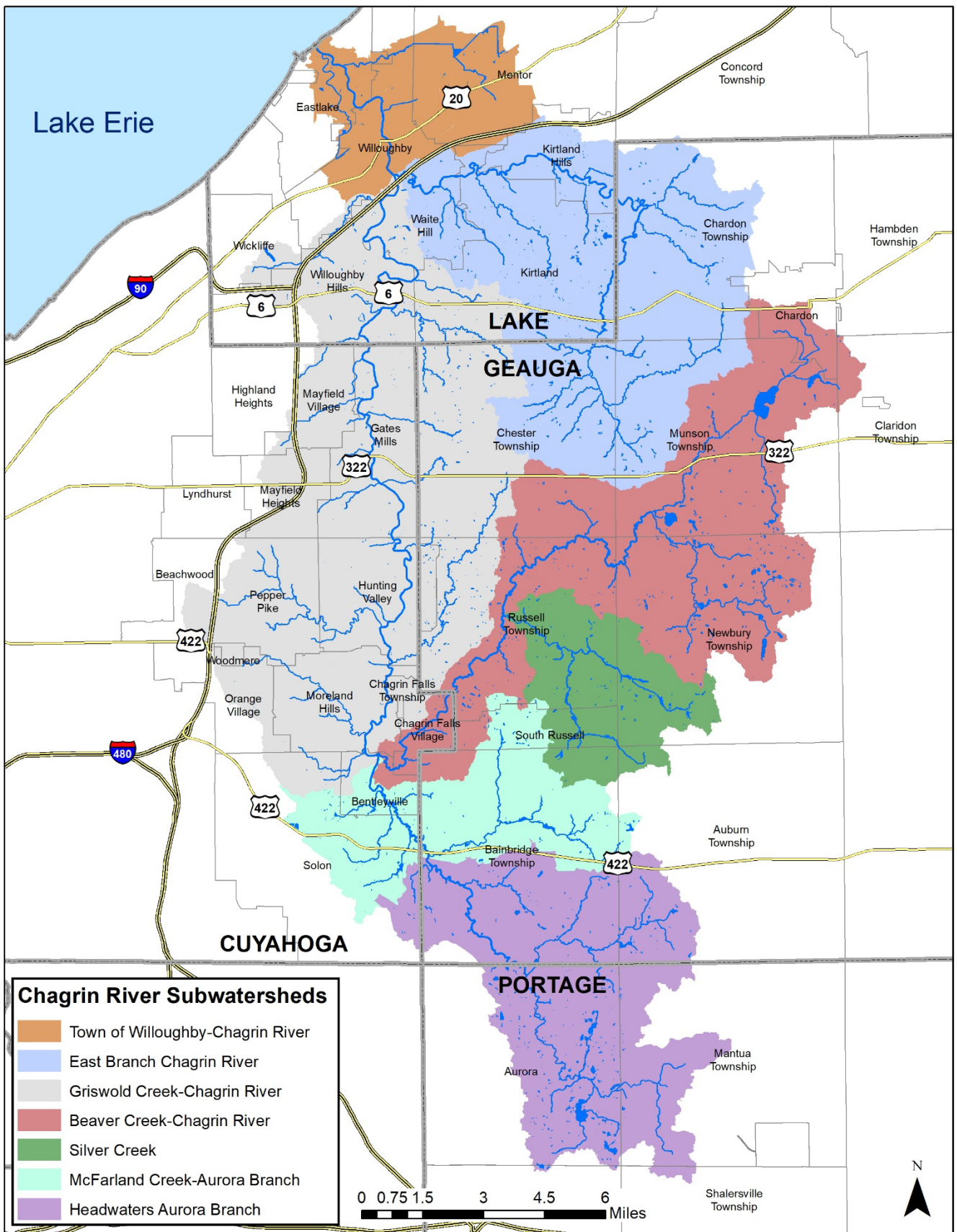


Figure 2: Chagrin River HUC-12 Subwatersheds

Table 1: Subwatersheds in the Chagrin River Watershed (Ohio EPA Integrated Report 2016)

Subwatershed	HUC-12	Drainage Area (square miles)	Relationship to East Branch-Chagrin River HUC-12
Town of Willoughby-Chagrin River	04110003 04 03	17.97	Adjacent, downstream
East Branch Chagrin River	04110003 04 01	51.33	-
Griswold Creek-Chagrin River	04110003 04 02	76.54	Adjacent, not connected
Beaver Creek-Chagrin River	04110003 03 04	47.48	Adjacent, not connected
Silver Creek	04110003 03 01	13.83	Not connected
McFarland Creek-Aurora Branch	04110003 03 03	20.42	Not connected
Headwaters Aurora Branch	04110003 03 02	37.5	Not connected

1.3 Public Participation and Involvement

Although CRWP was formed in 1996, the underlying concept of the watershed approach to managing the Chagrin River goes back more than forty years, when a group called the Chagrin Valley Association tried to establish a watershed coalition to address mounting concerns such as increased flooding, urbanization, water pollution, and loss of wilderness areas. Cleveland businessman John H. Byrne said in 1952, “This is why a Conservancy District (the equivalent of a watershed coalition) organization under the laws of Ohio and under local control is now a ‘must.’” The Chagrin Valley Association never succeeded in implementing a full watershed approach to managing the Chagrin River.

In 1986 the Chagrin River Land Conservancy (now the Western Reserve Land Conservancy (WRLC)) completed a strategic plan for their organization. The plan recommended that WRLC should encourage the creation of a separate entity to deal with the political and zoning issues in the Chagrin River watershed. In 1994 a group of concerned citizens began meeting to discuss the concept of a watershed approach to manage the Chagrin River. Led by private landowners, this group evolved into a coalition of municipalities, land trusts, county agencies and governments, state and federal agencies, park districts, schools, and other organizations with a stake in the Chagrin River watershed. In December 1995, a group of 75 representatives from these organizations endorsed the concept of forming a watershed coalition with a steering committee and a not-for-profit corporation in the State of Ohio. From this beginning, the Chagrin River Watershed Partners, Inc. (CRWP) was formed in 1996.

CRWP is organized and operated as an Ohio non-profit corporation and is qualified as a tax-exempt entity under Section 501(c)(3) of the Internal Revenue Code. Each member organization is entitled to elect one Regular Trustee to the Board of Directors which, in turn, is authorized to elect At Large Directors provided the At Large Directors do not exceed one-half of the Regular Directors. As of December 2016, the CRWP member organizations in the East Branch-Chagrin River HUC-12 are: Chardon township, Chester, City of Chardon, Kirtland, Kirtland Hills, Mentor, Munson, Waite Hill, Lake Metroparks, and Willoughby, representing 84.0% of the land area in the HUC-12.

CRWP maintains and updates the Chagrin WAP and is the primary author of the Chagrin River watershed NPS-IS plans, with input and assistance from its member organizations. CRWP members provided information on critical areas, high quality streams and wetlands, ongoing water quality monitoring efforts and potential projects to include in the NPS-IS plans at CRWP’s December 8, 2016 Board of Directors meeting. Paul Pira, Park Biologist with Geauga Park District, provided additional input for the East Branch-Chagrin River HUC-12 at a meeting held at CRWP offices on December 19, 2016. CRWP also met with Lake Metroparks staff on January 11, 2017.



Figure 3: NPS-IS Input Session, December 8 2016

Watershed planning in the Chagrin River watershed is a cooperative effort not only with CRWP members, but also with input and review by various local, county and state agencies. Sections of the East Branch-Chagrin River HUC-12 NPS-IS Plan address the programs and involvement of each of these stakeholders:

- Ohio Environmental Protection Agency
- Ohio Department of Natural Resources
- Cleveland Museum of Natural History
- Geauga County SWCD
- Lake County SWCD
- Geauga County General Health District
- Lake County General Health District
- Western Reserve Land Conservancy

CRWP will continue to update and refine this document as further information is gathered from our members and stakeholders and milestones are reached in the implementation of the East Branch-Chagrin River HUC-12 NPS-IS Plan.

Chapter 2: HUC-12 Watershed Characterization and Assessment Summary

2.1 Summary of HUC-12 Watershed Characterization

2.1.1 Physical and Natural Features

The East Branch-Chagrin River HUC-12 is located within Ohio's Erie-Ontario Lake Plains (EOLP) Ecoregion (Chagrin River TSD, 2006, p. 3). This subwatershed drains 51.33 square miles in portions of northwestern Geauga County and southwestern Lake County, including parts of Chardon, Chardon Township, Chester Township, Concord Township, Kirtland, Kirtland Hills, Mentor, Munson Township, Waite Hill, and Willoughby. The lower 15 miles of the East Branch has been designated a State Scenic River for its exceptional aquatic habitat and high quality riparian forests (Chagrin River WAP, 2011, p. 3). Tributaries in this subwatershed include Quarry Creek, Stoney Brook, Pierson Creek, Baldwin Creek/Shadybrook, Mt. Glen Tributary/Unnamed Tributary (RM 10.13), Stebbins Gulch, Harris Creek/Unnamed Tributary (RM 14.62), and several unnamed tributaries. Although historic wetland coverage in the HUC-12 was 4.27%, the current wetland coverage is 0.90%, indicating a loss of 79.03% of wetlands (Ohio Integrated Report 2016).

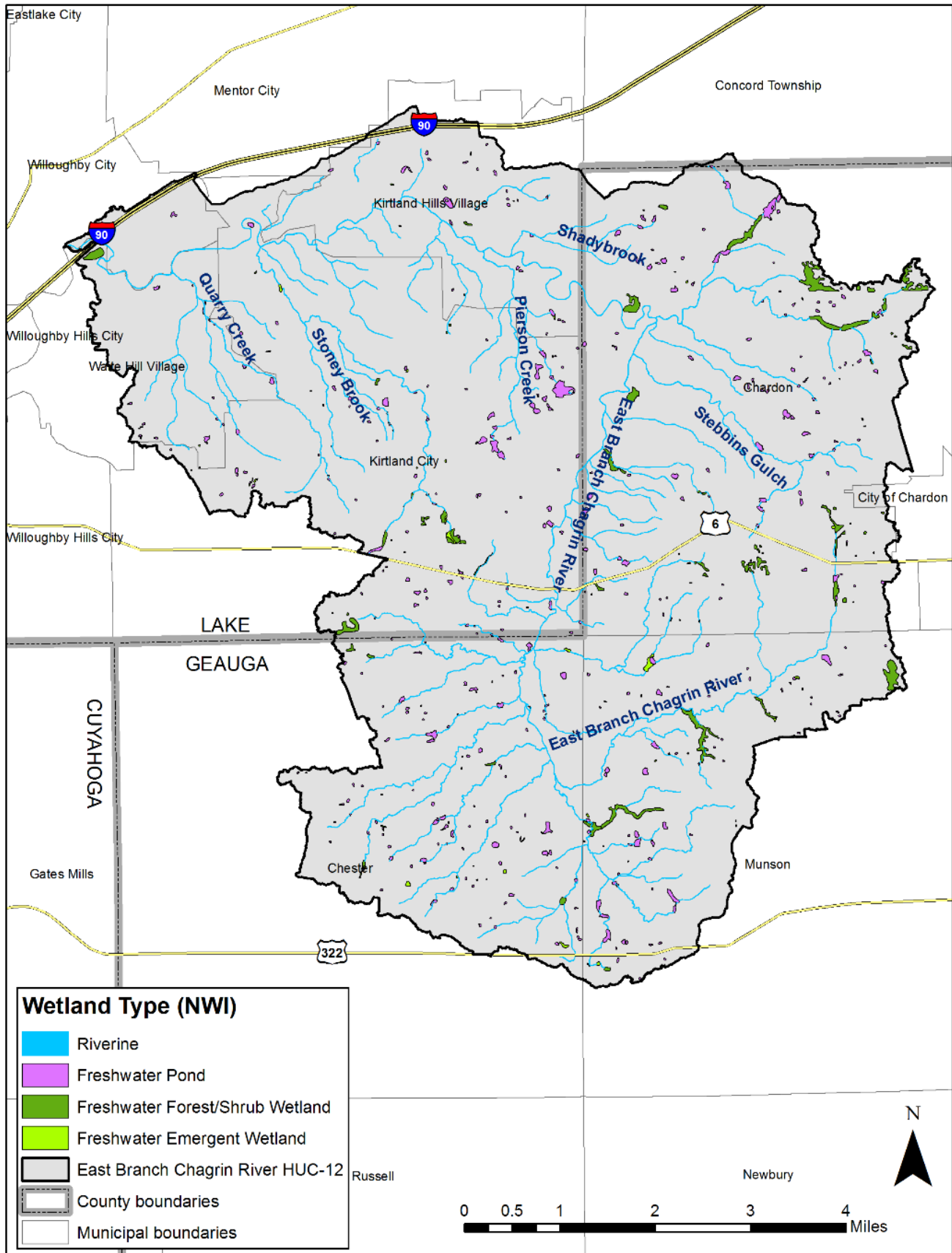


Figure 4: Wetland Types in East Branch-Chagrin River HUC-12 (Source: NWI)

Table 2: Wetland types, acreage, and percent of total in the East Branch-Chagrin River HUC-12 (Source: NWI).

Type	Acres	Percent of total
Riverine	350.34	37.31
Freshwater Forested/Shrub Wetland	267.07	28.44
Freshwater Pond	302.35	32.20
Freshwater Emergent Wetland	19.18	2.04
Total	938.95	100.00

This subwatershed includes parts of northwestern Geauga County and southwestern Lake County in Ohio. Communities with at least part of their boundary within the watershed include Chardon Township, Chester Township, City of Chardon, Concord Township, Kirtland City, Kirtland Hills Village, Mentor City, Munson Township, Waite Hill Village, and City of Willoughby. These communities are all members of CRWP, except for Chester and Concord Township. Geauga Park District, Lake Metroparks, and Lake County are additional members in this subwatershed.

Predominant soil types in the East Branch-Chagrin River subwatershed include Mahoning silt loam, 2 to 6 percent slopes (25.7%), Ellsworth silt loam, 25 to 70 percent slopes (9.2%), Ellsworth silt loam, 6 to 12 percent slopes (8.4%), Platea silt loam, 2 to 6 percent slopes (4.4%), Mahoning silt loam, 0 to 2 percent slopes (4.1%), and Orrville silt loam (3.4%).

Soils are also assigned to hydrologic soil groups. Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration soils. Only the soils that in their natural condition are in group D are assigned to dual classes. The predominant soil types in this subwatershed have high runoff potential and very slow infiltration rates. Type A and B soils are predominant along the East Branch corridor, but make up less than 5 percent of the East Branch-Chagrin River HUC-12. In contrast, C, B/D, C/D, and D together total 89 percent of the watershed.

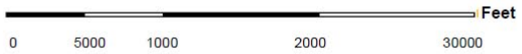
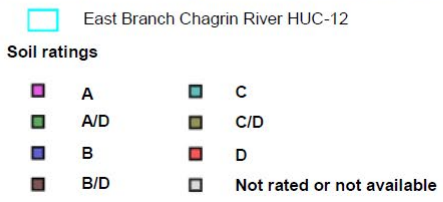
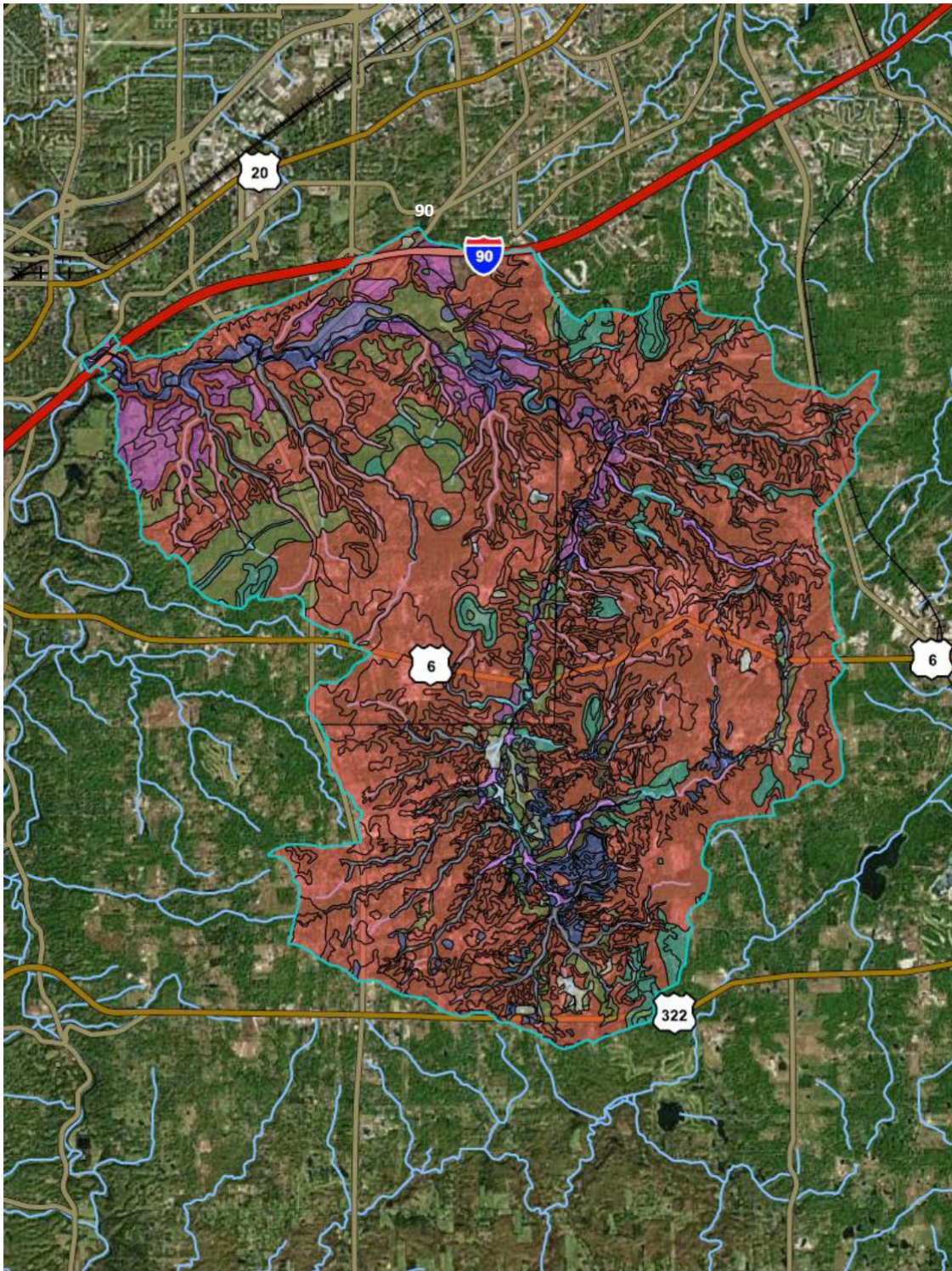


Figure 5: Hydrologic Soil Groups in the East Branch-Chagrin River HUC-12 (Source: USDA)

Table 3: Hydrologic Soil Groups in the East Branch-Chagrin River HUC-12 (Source: USDA)

Rating	Description	Total %
Group A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.	3.94
Group B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.	0.01
Group C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.	5.44
Group D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.	70.83
A/D Dual Class	First letter is for drained areas and the second is for undrained areas	0.0
B/D Dual Class	First letter is for drained areas and the second is for undrained areas	4.70
C/D Dual Class	First letter is for drained areas and the second is for undrained areas	8.01
NA	Not rated or not available	1.66

The major geologic types in this subwatershed are types of shale and siltstone. Ohio Shale is predominant along the East Branch mainstem.

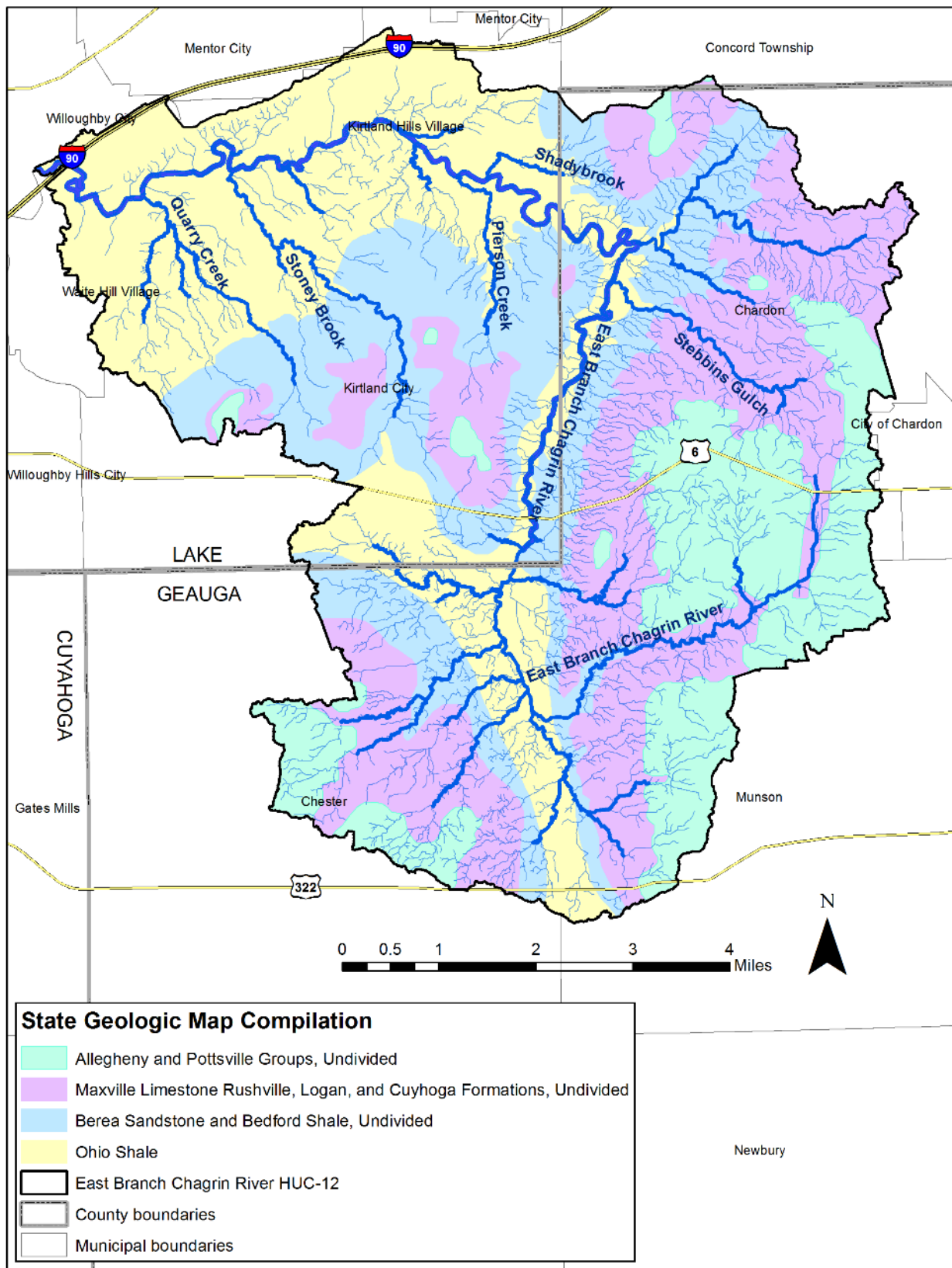


Figure 6: Bedrock geology in the East Branch-Chagrin River HUC-12 (Source: USGS)

Table 4: Geologic units in East Branch-Chagrin River HUC-12 (Source: USGS)

Name	Acres	Percent (%)
Berea Sandstone and Bedford Shale, Undivided	7546.24	22.92
Ohio Shale	10617.80	32.26
Maxville Limestone; Rushville, Logan, and Cuyhoga Formations, Undivided	9186.49	27.91
Allegheny and Pottsville Groups, Undivided	5567.42	16.91

Groundwater supplies are available from localized unconsolidated glacial deposits and from bedrock units. In Lake County, most of the groundwater resources are limited with pumping rates ranging from 0-25 gallons per minute (GPM). Much of the area produces less than 3 GPM due to heavy clay deposits overlaying shale bedrock. The most productive parts of the East Branch-Chagrin River subwatershed are in the eastern portion and the lowest yields are in the northwestern portion.

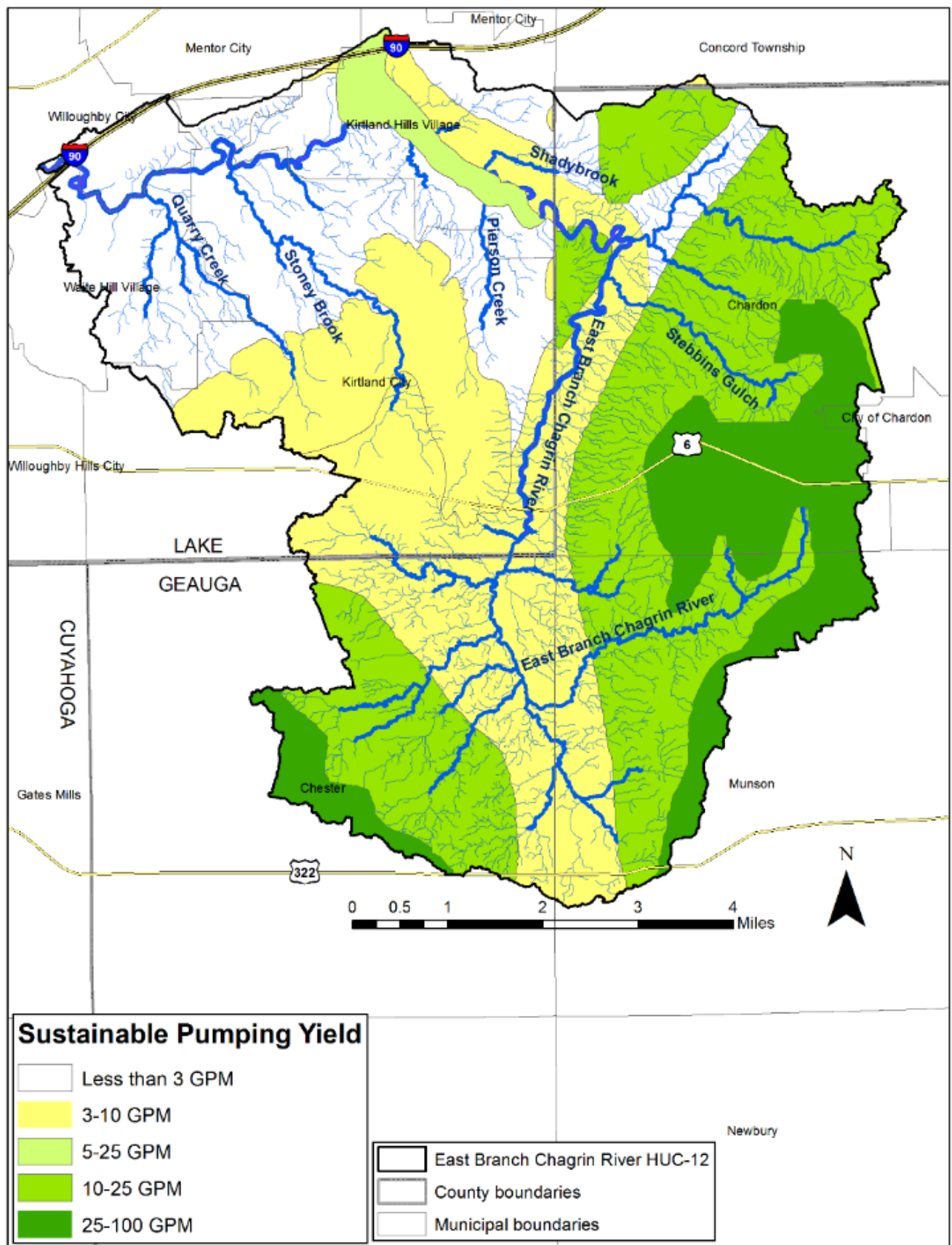


Figure 7: Groundwater sustainable pumping yields in East Branch-Chagrin River HUC-12.

Table 5: Groundwater resource map sustainable pumping yields (Source: ODNR, Division of Soil and Water)

Sustainable pumping yield	Acres	% of HUC-12
< 3 GPM	8069.81	24.50
3-10 GPM	10189.41	30.94
5-25 GPM	659.52	2.00
10-25 GPM	9903.38	30.07
25-100 GPM	4112.47	12.49

In Geauga County, residents rely almost exclusively on domestic and public-supply wells tapping groundwater for their drinking water. With steady population growth and the predominance of groundwater use in the county, county planners are concerned that water will be withdrawn faster than it is recharged. Domestic wells that do not have regular water-quality testing provide the drinking water for 79 percent of Geauga County’s residents. The USGS is monitoring groundwater levels in 30 wells across Geauga County that are open to four widely used aquifers, the glacial deposits, the Pottsville Formation, the Cuyahoga Group, and the Berea Sandstone. Understanding the magnitude and locations of groundwater declines will assist in planning for continued growth and conservation of groundwater resources. Increases in population size in the county may influence groundwater resources as people withdraw more groundwater, disposing more human waste near the land surface, treat more roads with deicing salt, and likely increase use of chemicals such as solvents and pesticides. The USGS found that the primary effect of human activities on groundwater in Geauga County was the input of salinity, or chloride, from road salt and septic leachate (Jagucki et al. 2015).

The DRASTIC mapping system was chosen by ODNR to allow the pollution potential of an aquifer to be evaluated systematically using existing information. The DRASTIC system consists of two major elements:

1. Designation of mappable units, termed hydrogeologic settings, and
2. Superposition of a relative rating system to determine the pollution potential.

Hydrogeologic settings represent mappable units with common hydrogeologic characteristics and, consequently, common vulnerability to contamination. Hydrogeologic settings form the basis of the system and incorporate the seven major hydrogeologic factors that affect and control ground water movement and occurrence, that are:

- Depth to Water
- Recharge (Net Recharge)
- Aquifer Media
- Soil Media
- Topography (% slope)
- Impact of the Vadose Zone Media Conductivity (Hydraulic) of the Aquifer)
- Conductivity (Hydraulic) of the Aquifer

DRASTIC uses a numerical rating and weighting system that is combined with the seven DRASTIC factors listed above to calculate a ground water pollution potential index or relative measure of vulnerability to contamination. The higher DRASTIC index number correlates to a greater vulnerability to contamination.

The areas of highest groundwater pollution potential in the East Branch-Chagrin River HUC-12 are focused along major stream corridors.

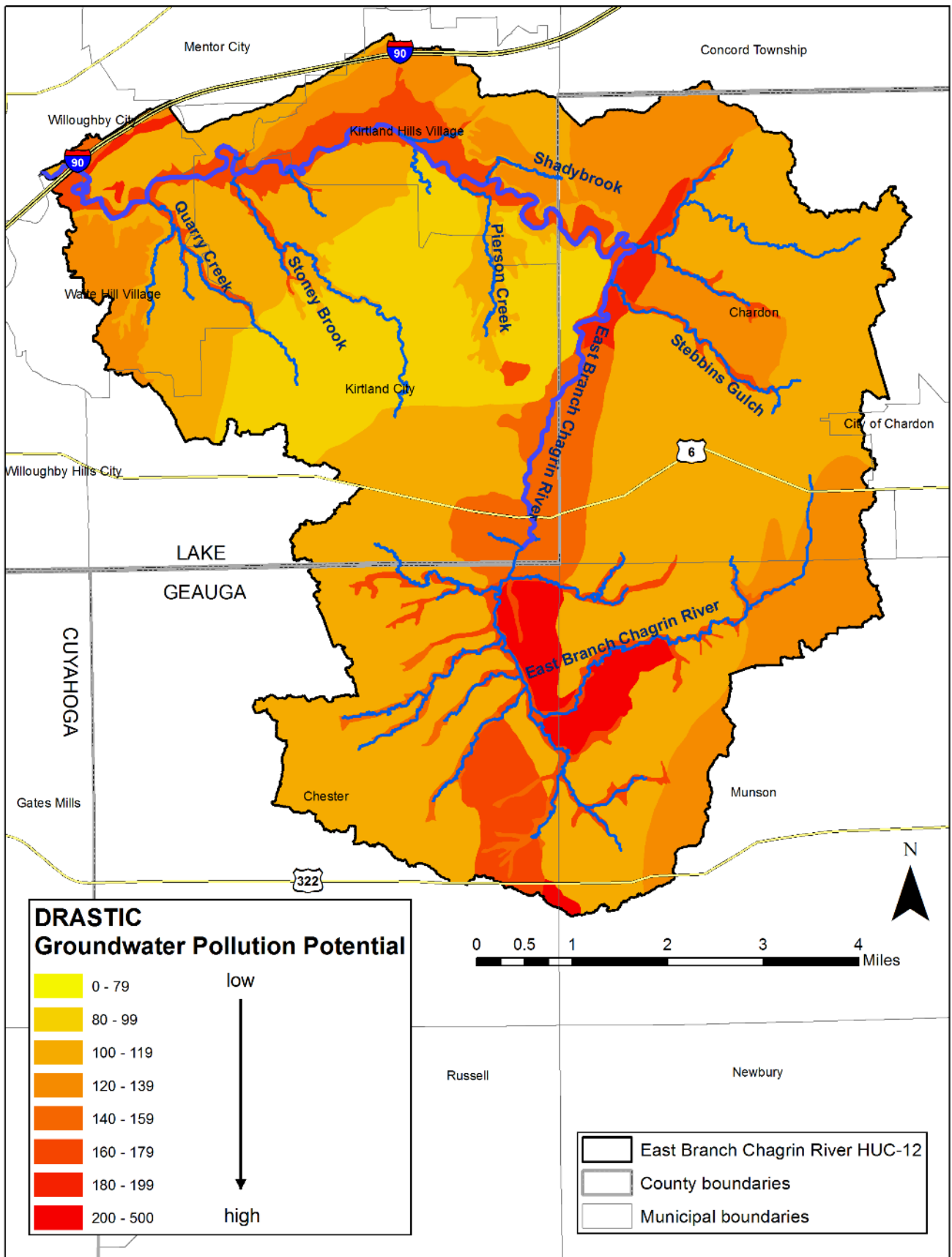


Figure 8: Groundwater Pollution Potential in the East Branch-Chagrin River HUC-12.

Invasive species are a growing concern as they threaten the biological diversity and integrity of the East-Branch Chagrin River HUC-12. A 2006 BioBlitz field survey at Sunnybrook Preserve, conducted June 3, 2006 by Geauga Park District, revealed establishment of the following invasive plants:

Table 6: Invasive plants found at Sunnybrook Preserve (Pira, 2007, p. 74)

Common name	Scientific name
Privet	<i>Ligustrum vulgare</i>
Multiflora Rose	<i>Rosa multiflora</i>
Canada Thistle	<i>Cirsium arvense</i>
Japanese Honeysuckle	<i>Lonicera japonica</i>
Buckthorn	<i>Rhamnus cathartica</i>
Garlic Mustard	<i>Allaria petiolata</i>
Common Reed Grass	<i>Phragmites australis</i>
Lesser Celandine	<i>Ranunculus ficaria</i>

2.1.2 Land Use and Protection

The East Branch is the least developed of the Chagrin 12 digit HUC watersheds. It is experiencing development pressures in the upper reaches of the watershed and encroachment on headwater streams. This has resulted in riparian vegetation removal.

Land use in the East Branch Chagrin River HUC-12 is estimated by Ohio EPA in their 2016 Watershed Assessment Unit Summary as 25.20% Developed, 53.90% Forest, 13.70% Grass/Pasture, 6.90% Row Crops, and 0.20% Other (such as open water). 2010 data from NOAA’s Coastal Analysis Change Program (CCAP) shows the dominant types of developed land use in the HUC-12 are deciduous forest and low intensity rural and suburban development.

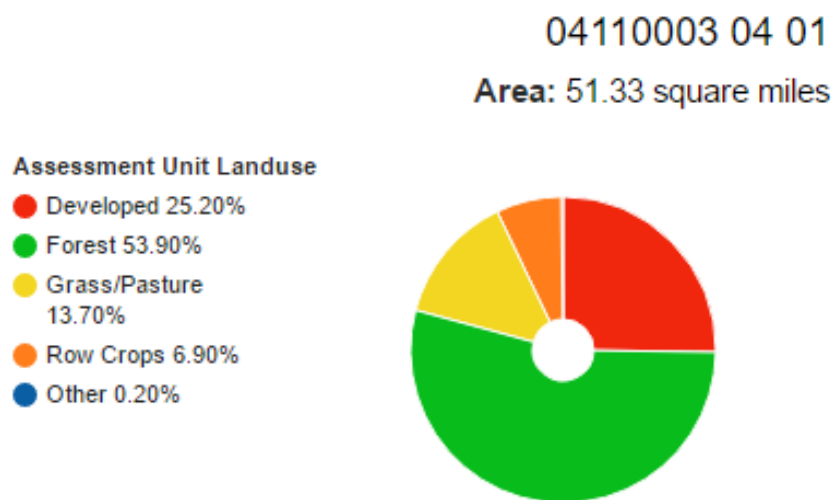


Figure 9: Land use in East Branch-Chagrin River (Source: Ohio EPA Integrated Report)

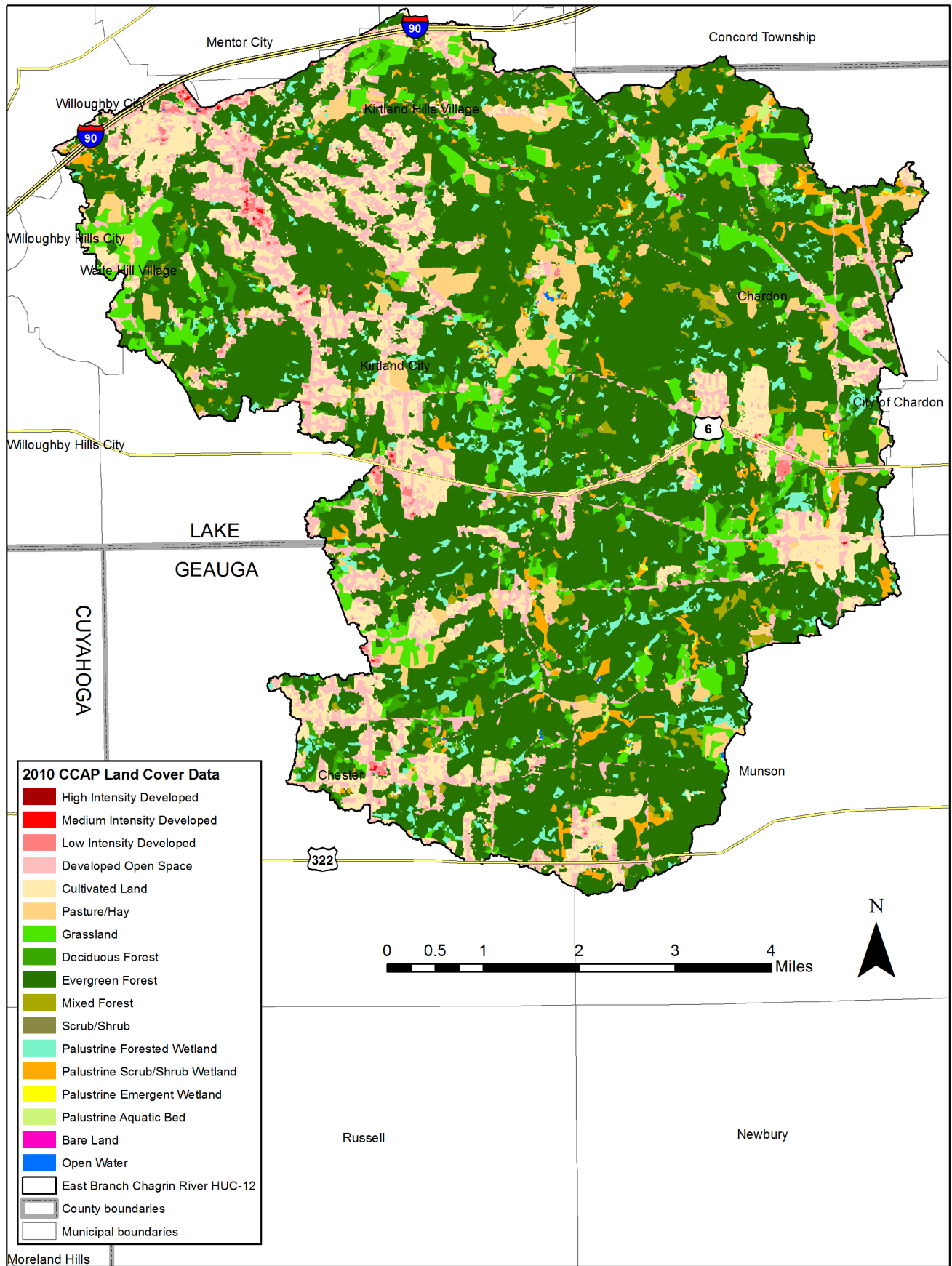


Figure 10: Land use in East Branch-Chagrin River HUC-12 (Source: CCAP)

Table 7: Land use in East Branch-Chagrin River HUC-12 (Source: CCAP)

Cover Classification	Area (acres)	% of HUC-12
Developed, high intensity	19.66	0.06
Developed, medium intensity	203.11	0.62
Developed, low intensity	3372.34	10.25
Developed, open space	3311.8	10.06
Cultivated crops	1498.76	4.55
Pasture/hay	2062.32	6.27
Grassland/herbaceous	1156.8	3.52
Deciduous forest	18779.08	57.07
Evergreen forest	464.57	1.41
Mixed forest	35.63	0.11
Scrub/shrub	1182.09	3.59
Palustrine forested wetland	657.17	2
Palustrine scrub/shrub wetland	23.24	0.07
Palustrine emergent wetland	28.65	0.09
Bare land	5.85	0.02
Open water	104.96	0.32

Using USGS’s StreamStats for the entire East Branch (approximately 51 square miles), percent forest cover is slightly higher than CCAP, at 71.4 percent of the watershed. Percent impervious area, determined from the National Land Cover Data (NLCD) 2011 impervious dataset, is low, at only 3.91 percent for the HUC-12.

This HUC-12 includes the following protected areas:

- Holden Arboretum: This is a private organization and includes the actively managed Arboretum collection used by horticulture professionals around the world, and many horse, hiking, and skiing trails available for member use. Holden owns approximately 3,400 acres and holds conservation easements on an additional 1,240 acres in Lake and Geauga Counties in the East Branch Chagrin River HUC-12 (Chagrin River WAP 2011, p. 35).
- Geauga Park District
 - o Sunnybrook Preserve: This 73-acre preserve is located in Chester Township on Heath Road between Wilson Mills Road and Mayfield Road. Sunnybrook Preserve is characterized by its rolling terrain formed by glacial deposits.
 - o Hehmeyer Preserve: This 27.81 acre preserve is located in Chester Township south of Wilson Mills Rd (permanent parcel numbers are 11-714462 and 11-714463)
- Lake Metroparks
 - o Farmpark: This 235-acre farm is located in Kirtland. This is a family-oriented science and cultural center devoted to agriculture and farming.

- Chapin Forest Reservation: This 403-acre preserve is under a lease agreement with the Ohio Department of Natural Resources Division of Forestry. The ledges are rocky outcroppings of Sharon Conglomerate, formed approximately 300 million years ago.
- Penitentiary Glen Reservation: This 424-acre preserve is known for its deep gorge, which divides the park in two.
- Cleveland Museum of Natural History
 - Koelliker Fen Preserve: This is a 12-acre preserve in Munson Township. Plant communities includes rare orchids, a star-flowered Solomon's seal and poison sumac. The cloudy arches moth has also been found here. Invasive, narrow-leaved cattails have been identified here.
- Golf courses/clubs
 - Berkshire Hills Golf Course
 - Legend Lake Golf Club
 - St. Dennis Golf Club and Party Center
 - The Kirtland Club
- Lakeland Community College
- Cemeteries

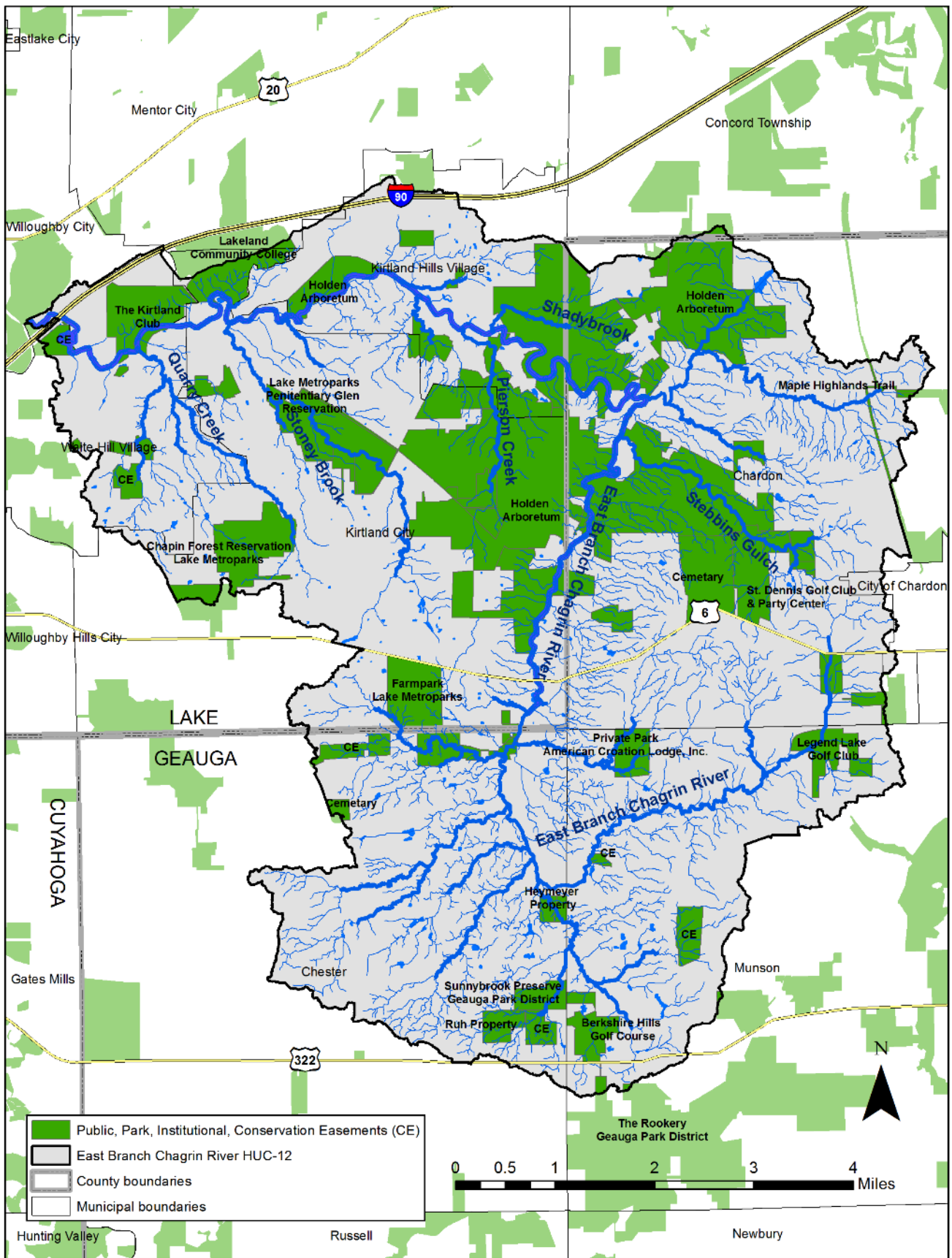


Figure 11: Protected areas in East Branch-Chagrin River HUC-12

Much of the East Branch Chagrin River subwatershed is designated as Priority Conservation Area (PCA). CRWP and its watershed communities collaborated on the development of the *Chagrin River Watershed Balanced Growth Plan* from 2006 - 2009. Through this process, Priority Conservation Areas (PCAs) and Priority Development Areas (PDAs) were identified and mapped for the watershed's communities and incorporated into the communities' comprehensive land use plans. PCAs are locally designated areas for protection and restoration. They may be important ecological, recreational, heritage, agricultural, and public access areas that are significant for their contribution to Lake Erie water quality and general quality of life. PDAs are locally designated areas where development and/or redevelopment is to be encouraged in order to maximize development potential, maximize the efficient use of infrastructure, promote the revitalization of cities and towns, and contribute to the restoration of Lake Erie (*Chagrin River Watershed Balanced Growth Plan*, 2009).

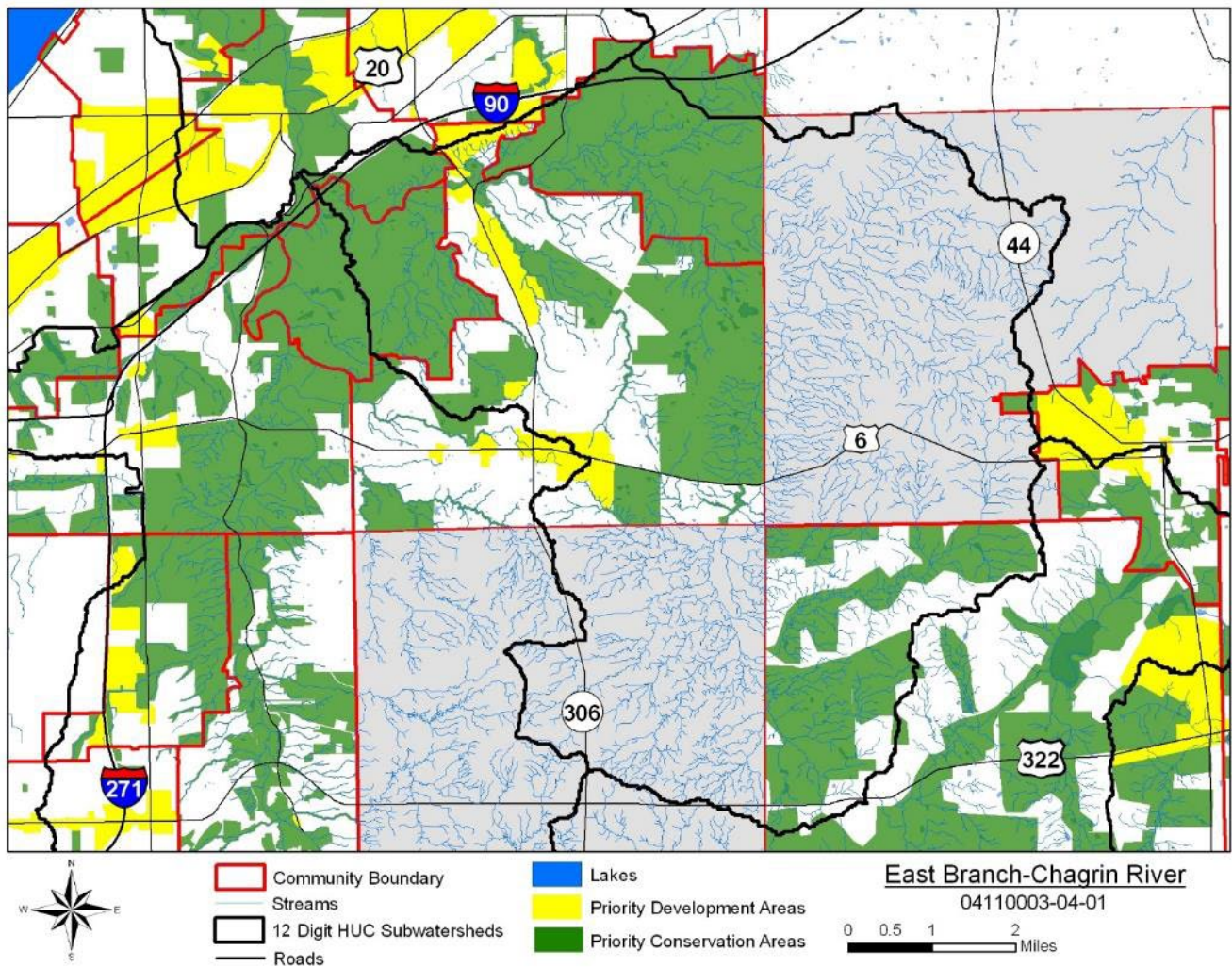


Figure 12: Balanced Growth planning in East Branch-Chagrin River HUC-12.

2.2 Summary of HUC-12 Biological Trends

In 2003-2004 Ohio EPA sampled throughout the Chagrin River watershed and in December 2006 they released *Biological and Water Quality Study of the Chagrin River and Selected Tributaries, 2003-04 Technical Report EAS/2006-12-7*. The report was used extensively in the development of the East Branch-Chagrin River HUC-12 NPS-IS Plan. Since the publication of the Chagrin River TSD (2006), additional sampling and monitoring has been completed by Ohio EPA and listed in the *2016 Integrated Report*.

The East Branch-Chagrin River HUC-12 is unique in that the East Branch and all of its tributaries are designated CWH or CWH/EWH by Ohio EPA. Ohio EPA noted that the East Branch Chagrin River from RM 14.49 (Heath Road) to the mouth is designated as Outstanding State Resource Water in OAC-3745-1-05, Table 5-5, and has the potential to support one of the highest diversity of aquatic communities in Ohio (TSD, p.2). Land protection in much of the HUC-12 has allowed sensitive coldwater organisms to flourish. Organizations like Lake Metroparks work to educate the public about the ecological significance of coldwater habitats and the need to protect them. Signage at Penitentiary Glen Reservation, for example, notes that “Stoney Brook is a permanent stream designated as a coldwater habitat. These oxygen-rich waters and the surrounding valley support populations of native coldwater fish, insects, birds, amphibians, plants, and other organisms. The dense trees lining the stream corridor provide shade, stabilize the soil and filter surface water. Without these trees, the sun would warm the water, soil would erode and pollutants would enter the stream, causing coldwater organisms to disappear.”



Figure 13: Coldwater habitat sign at Penitentiary Glen near Stoney Brook tributary (CRWP, 8/12/2016)



Figure 14: Stoney Brook at Penitentiary Glen Reservation (CRWP, 10/29/2016)

All recent Ohio EPA assessment points in the East Branch-Chagrin River HUC-12 show full attainment of their coldwater aquatic life use, except for three points on the East Branch mainstem of the Chagrin River. The number labels on the map correspond to the table numbers.

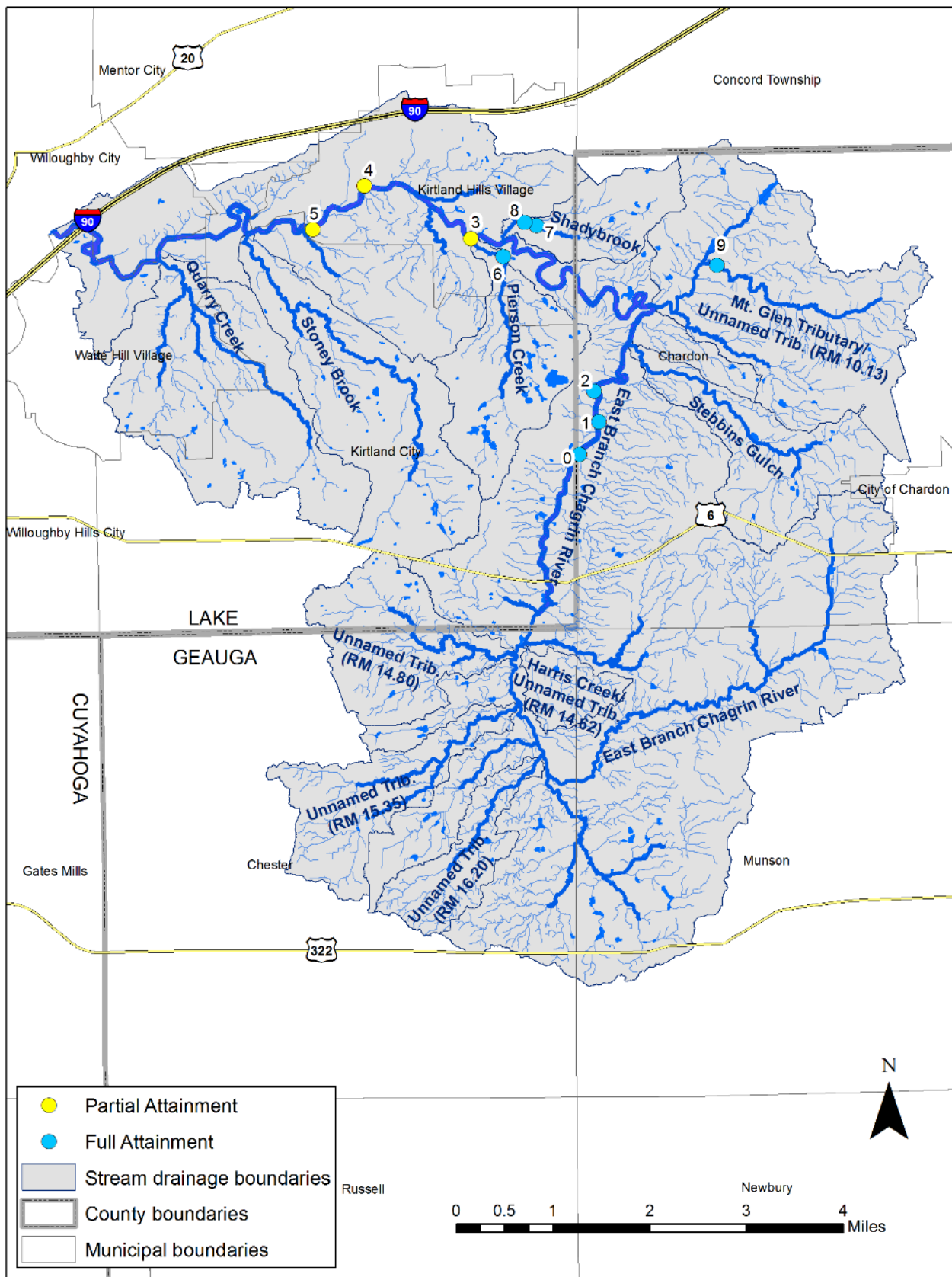


Figure 15: ALU Assessment Points in East Branch-Chagrin River HUC-12 (Ohio EPA Integrated Report)

Table 8: Biological Indices Scores for East Branch-Chagrin River (Ohio EPA Integrated Report 2016)

Station ID	Sample Station Name	River Mile (Drainage Area mi ²)	ALU Type	Fish Sample Year	IBI Score	IBI Desc.	Mlwb Score	Mlwb Desc.	Bug Sample Year	ICI Score	ICI Desc.	QHEI
0	E. BR. CHAGRIN R. @ KIRTLAND RD.	12.15 (22.4)	Full CWH	2015	41	G	8.35	G	2015	54	E	76
1	E. BR. CHAGRIN R. ADJ. WISNER RD. @ RIVERWOOD FARM	11.75 (23.5)	Full CWH	2015	42	G	8.37	G	2015	56	E	85
2	E. BR. CHAGRIN R. @ WISNER RD,	11.38 (24.2)	Full CWH	2015	42	G	7.95	MG	2012	46	E	74
3	E. BR. CHAGRIN R. AT KIRTLAND @ BOOTH RD.	6.68 (36.9)	Partial CWH	2007	46	VG	7.57	F	2007	46	E	78
4	E. BR. CHAGRIN R. NEAR KIRTLAND @ SHOOTING RANGE	5.1 (44.3)	Partial CWH	2007	36	MG	7.71	MG	2007	48	E	60
5	E. BR. CHAGRIN R. NEAR KIRTLAND, DST OSBOURNE CHANNEL IMPACT	4.3 (44.8)	Partial CWH	2007	42	G	7.5	F	2007	48	E	68
6	PIERSON CREEK UPST. SPERRY RD.	0.4 (1.9)	Full EWH/ CWH		NA		NA		2009	NA	VG	NA
7	SHADYBROOK RUN AT KIRTLAND HILLS, UPST. RESTORATION AREA	0.6 (0.8)	Full CWH	2011	24	P	NA		2011	NA	G	77.8
8	SHADYBROOK RUN AT KIRTLAND HILLS, WITHIN OLD IMPOUNDMENT	0.5 (0.8)	Full CWH	2011	24	P	NA		2011	NA	G	72
9	TRIB. TO E. BR. CHAGRIN R. (10.13/0.87) @ MT. GLEN PROPERTY	0.2 (1.9)	Full CWH		NA		NA		2009	NA	MG	NA

P = Poor, F = Fair, MG = Marginally Good, G= Good, VG = Very Good, E = Exceptional

Table 9: Additional EPA assessment points (Chagrin River TSD, 2006)

RIVER MILE	2003/04	2003/04	2003/04	2003/04	2003/04	2003/04	Site Location
Fish/Invert.	IBI	MIwb ^a	ICI ^b	#CW ^c Fish/bugs	QHEI	Attainment Status	
East Branch Chagrin River (2004)							EOLP: CWH Use Designation (Existing)
16.3	42	-	E	1+/6	76.0	FULL but declining ^E	at Heath Rd.
10.3 / 10.2	42	4.5	E	1+/7	70.0	FULL but declining ^F	Adj. Wisner Rd. dst. Mitchells Mills Rd.
2.4	42	8.2	VG	0+/2	76.0	NON	Ust. Markell Rd.
Quarry Creek (2004) (Trib. to E. Br. Chagrin R. @ RM 1.85)							EOLP: CWH (Existing) and EWH Use Designation (Recommended)
0.1	56	-	VG ^{ns}	1+/5	55.0	FULL/FULL	Markell Rd.
Stoney Brook (2004) (Trib. to E. Br. Chagrin R. @ RM 3.57)							EOLP: CWH Use Designation (Existing)
0.1	40	-	VG	0+/4	65.5	PARTIAL	Kirtland Chardon Rd. (SR 615)
Pierson Creek (2004) (Trib. to E. Br. Chagrin R. @ RM 6.73)							EOLP: CWH (Existing) and EWH Use Designation (Recommended)
0.1	56	-	VG ^{ns}	1+/11	66.5	FULL/FULL	Sperry Rd. and Booth Rd.
Trib. to E. Br. Chagrin R. @ RM 10.13 (2004)							EOLP: CWH (Existing) and EWH Use Designation (Recommended)
0.1	48 ^{ns}	-	54	1+/12	78.0	FULL/FULL	near mouth dst. Wisner Rd.

Stebbins Gulch (2004) (Trib. to E. Br. Chagrin R. @ RM 10.60)							EOLP: CWH Use Designation (Existing)
0.2	38	-	E	1+/14	68.5	FULL	Ust. Wisner R. & south of Mitchell Mill Rd.
Trib. to E. Br. Chagrin R. @ RM 14.62 (east side trib.) (Harris Cr.) (2004)							EOLP: CWH Use Designation (Existing)
0.1	38	-	E	0+/8	62.5	PARTIAL	
Trib. to E. Br. Chagrin R. @ RM 14.80 (west side trib.) (2004)							EOLP: CWH Use Designation (Existing)
0.1	48	-	G	0+/6	63.5	PARTIAL	Sperry Rd.
Trib. to E. Br. Chagrin R. @ RM 15.35 (west side trib.) (2004)							EOLP: CWH (Existing) and EWH Use Designation
0.2	46 ^{ns}	-	VG ^{ns}	0+/7	72.5	PARTIAL (CWH) / FULL (EWH)	Sperry Rd.
Trib. to E. Br. Chagrin R. @ RM 16.2 (2004)							EOLP: CWH (Existing) and EWH Use Designation (Recommended)
0.2 / 0.1	50	-	E	1+/12	72.5	FULL/FULL	Wilson Mills Rd.

a - MIwb is not applicable to headwater streams with drainage areas $\leq 20\text{mi}^2$

b - A qualitative narrative evaluation based on community composition, EPT taxa richness, and other attributes. E = Exceptional, VG = Very Good, G = Good, MG = Marginally Good, F = Fair, P = Poor, VP = Very Poor.

c - Attainment of CWH evaluated on presence and quality of CW fish {Ohio EPA CW list (trouts, sculpins, brook stickleback, redbreast dace) & other additional species (e.g., Longnose dace, American Brook lamprey, mudminnow, blacknose dace, and white sucker - specific interpretation based on local collection - presence, distribution & habitat)} and > 4 CW macroinvertebrates (from Ohio EPA current list) & narrative quality. If CW fish from Ohio EPA CW list were present, the total number of different CW fish taxa were listed, and a footnote (+) was added if additional potential coolwater/cold water fish were present from the additional species list. Full but Declining is noted when a lack of quality or decreased quality is documented by decreases in the cold water fish assemblages or macroinvertebrate assemblages over time.

ns- Nonsignificant departure from biocriteria (< 4 IBI or ICI units, or < 0.5 MIwb units).

E- This upper reach showed a documented historical decrease in quality of the CW community (no rainbow trout, American brook lamprey, and only a remnant Longnose dace population present compared to earlier data).

F- This reach sampled had a low fish biomass quality score & high sediment load - directly related to dredging. Also there was historical decrease in CW fish community quality (loss of brook trout, American brook lamprey, and large decreases (60-80%) in Blacknose dace and Longnose dace). Some stretches of reach contained sandy bedload covering large substrates. Where habitat was better as indicated by QHEI, the macroinvertebrate community was present in those areas.

Table 10: General narrative ranges for QHEI (QHEI Manual June 2006)

Narrative rating	QHEI Range	
	Headwaters	Larger Streams
Excellent	≥ 70	≥ 75
Good	55 to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	< 30	< 30

Table 11: Drainage area, percent forest cover, and percent impervious cover of main tributaries in East Branch-Chagrin River HUC-12 (USGS Streamstats)

Stream	Drainage (mi ²)	% Forest	Impervious Cover (%)
Quarry Creek	3.96	69.2	5.38
Stoney Brook	3.43	73	6.68
Pierson Creek	2.37	72	1.35
Baldwin Creek/Shadybrook	1.1	82.5	0.69
Mt. Glen Tributary/Unnamed Tributary	4.77	74.9	1.94
Stebbins Gulch	2.11	72.5	3.09
Harris Creek/Unnamed Trib	0.73	76.9	1.53
Unnamed Tributary 14.80	2.13	66.8	5.17
Unnamed Tributary 15.35	1.94	63.7	6.22
Unnamed Tributary 16.2	1.06	78	3.76
Entire East Branch	51	71.4	3.91

As Ohio EPA has no numeric criteria set for CWH streams, assessed CWH streams were determined to be in attainment of their CWH aquatic life use status based on the presence and absence and quality of coldwater fish species and at least four coldwater macroinvertebrate taxa. Fish species evaluated for the Ohio EPA coldwater taxa list are trouts, sculpins, brook stickleback, and redbreast dace; additional species (longnose dace, American brook lamprey, mudminnow, blacknose dace or other daces, and white sucker) were considered for specific interpretation based on presence, distribution, and habitat in local collection. Increased urbanization in the East Branch-Chagrin River may contribute to loss of coldwater habitats, and protection of those streams that are documented to be fully attaining the CWH aquatic life designation should be given a very high priority for planning efforts in the HUC-12.

Fishes (Modified Index of Well-Being [MIwb], Index of Biotic Integrity [IBI] and presence/absence of coldwater fish species)

Due to the uniquely abundant coldwater habitat in this HUC-12, reintroductions of brook trout (*Salvelinus fontinalis*), a state threatened species, have been successful in several East Branch-Chagrin River tributaries (Chagrin River TSD, 2007, pg. 15). Ohio brook trout were thought to be extinct until 1972, when Dr. Andrew White of John Carroll University found two reproducing populations of native brook trout in the headwaters of the Chagrin River. The Ohio Division of Wildlife initiated a project in 1996 to reintroduce native Ohio brook trout to streams primarily within the Chagrin River watershed. Growth and survival rates as well as reproduction success

was extensively monitored. Several streams in the East Branch of the Chagrin River were stocked with native Ohio brook trout, including Pierson Creek, Baldwin Creek/Shadybrook, Mt. Glen Tributary, and an unnamed tributary (East Branch RM 16.2). High quality brook trout habitat is characterized as clear and cold spring-fed streams with silt-free rocky substrate in the riffles, high canopy cover or instream cover, abundant cold-water adapted benthic macroinvertebrate taxa, and stable water flows (Amey 2014).

Table 12: Reintroduction sites for brook trout (*Salvelinus fontinalis*) in East Branch-Chagrin River HUC-12 (Burt, 2007)

Stream or landowner	Years stocked	Years Surveyed	Avg. Fry % Survival	Population Size
Baldwin Creek / Shadybrook	2001-2003	2001-2006	1.95%	Fail
Mt. Glen Farm	2001,2003	2001-2006	0.87%	Small
Muir Valley	2001-2003	2001-2006	5.92%	Large
Palsa	2001-2003	2001-2003	5.49%	Small
Pierson Creek	2001	2001-2003, 2005-2006	0.36%	Fail

Muir Valley was considered to have a strong, self-sustaining population of brook trout. Palsa and Mt. Glen were noted as having demonstrated high recruitment and survival variability in the monitoring surveys. Baldwin Creek and Pierson Creek did not have successful reintroductions (Burt, 2007). Protection of coldwater streams and their riparian and groundwater recharge areas is vital for maintaining brook trout (Chagrin River TMDL, 2007).



Figure 16: Southern redbelly dace (*Phoxinus erythrogaster*) top and redbside dace (*Clinostomus elongatus*) bottom found in Sunnybrook’s mainstem, 2006 (Source: Pira, 2007).

The tributaries in the East Branch-Chagrin River contain several sites exhibiting exceptional and diverse fish populations. Pierson Creek and Quarry Creek both have exceptional IBI scores of 56 and harbor longnose dace (Quarry Creek and Pierson Creek) and river chub (Pierson Creek). Southern redbelly dace and redbside dace were found in Sunnybrook’s main stem in 2006 (Pira 2007, p. 58). Other tributaries like Stoney Brook (Trib. to E. Br. Chagrin R. at RM 3.57), Harris Creek (Trib. to E. Br. at RM 14.62), and an unnamed tributary to the East Branch at RM 15.35 exhibited either non- or partial attainment of their CWH status due to absence of coldwater fish species at the time of sampling. Nonpoint source stormwater runoff and fish barriers from in-stream structures and bridges are identified as the source of the impairments.

MIwb and IBI scores were assessed during sampling for the East Branch, although it should be noted the assessments are for WWH and EWH attainment, as CWH attainment has no numeric criteria established. The East Branch of the Chagrin upstream of Mitchells Mills road was identified as in CWH attainment but has a Poor MIwb score, indicating a stressed fish community from the effects of sediment mining. Two tributaries to the East Branch at RM 10.6 and RM 14.62 had IBI scores of Marginal (38), also indicating a stressed fish community. Most sites sampled in the East Branch and its tributaries, however, harbor fish communities that meet numeric water

quality standards for biological integrity. The strong population of longnose dace noted during sampling and the presence of young-of-the-year steelhead trout in the mainstem East Branch and tributaries indicate that the East Branch is maintaining its coldwater character.

Macroinvertebrates (Invertebrate Community Index [ICI] and presence/absence of coldwater macroinvertebrate taxa)

The East Branch Chagrin River at Heath Rd. (RM 16.3) is a high-quality gradient stream that contained six coldwater taxa, including the stonefly *Sweltsa* and the caddisfly *Glossosoma*, confirming its coldwater attributes. The community was identified as Exceptional, with 20 EPT and 30 sensitive taxa documented. At RM 10.2 (Wisner and Mitchells Mills Rd.), clean substrates in the riffles and run harbored an Exceptional macroinvertebrate community despite gravel bedload burying larger substrates in slower depositional areas, with 7 coldwater taxa present and 26 sensitive taxa. Loss of riparian corridor, higher temperatures, and influences from suburbanization have influenced the CWH macroinvertebrate community with only two coldwater taxa collected, but overall the community was Very Good with 17 EPT taxa and 25 sensitive taxa. Riparian restoration and stormwater controls should stabilize and improve the macroinvertebrate community quality and coldwater attributes in the lower reach of the East Branch.

The tributaries to the East Branch, overall, exhibited high quality macroinvertebrate communities including presence of coldwater taxa. The tributary to the East Branch at RM 16.2 near Wilson Mills Rd. had 12 coldwater taxa, including two rare and intolerant caddisfly species, *Psilotreta indecisa* and *Ceratopsyche ventura*, and predominant organisms were coldwater caddisflies and mayflies. The riparian corridor in this reach is mostly large trees which help maintain in-stream temperatures. The tributary to the East Branch at RM 15.35 near Sperry Rd. met recommended EWH criteria with a Very Good macroinvertebrate narrative, as well as coldwater criteria with the presence of 7 coldwater taxa including the mayfly *Baetra tricaudatus*, the caddisfly *Ceratopsyche slossonae*, and the midge *Polypedilum aviceps*. However, it is noted that substrate embeddedness is affecting the community in this reach, due to absence of expected caddisfly species like *Chimarra* and *Glossosoma*, and a denser riparian corridor is recommended. The tributary to the East Branch at RM 14.8 supported six coldwater taxa, however the macroinvertebrate community was not as diverse as the upstream tributary (RM 15.35) due to embedded riffles and runs. Moderate to high densities of filter-feeding caddisflies were attributed to nutrient inputs and open canopy conditions. The tributary to the East Branch at RM 14.62 has a nearly intact forested upstream system which is attributed to the Exceptional quality macroinvertebrate community, including coldwater caddisflies. Stebbins Gulch is notable as a pristine high-gradient coldwater stream that had 37 sensitive taxa and 26 EPT taxa; coldwater mayflies and caddisflies were the predominant organisms collected. Two of the three stonefly taxa collected were coldwater taxa. A total of fourteen coldwater taxa were collected at Stebbins Gulch, and the stream may be a viable brook trout reintroduction site. The tributary to the East Branch at RM 10.13 supports an Exceptional macroinvertebrate community with a robust wooded corridor and mostly shaded conditions, and 12 coldwater taxa were collected at the site. Pierson Creek had a Very Good macroinvertebrate community and eleven coldwater taxa collected. However, slight embeddedness in the substrate here was noted and seemed to limit the totals of sensitive taxa, as only 24 sensitive taxa and 16 EPT taxa were found. Stoney Brook barely meets CWH macroinvertebrate criteria with only four coldwater taxa found. Nutrient enriched conditions attributed to nonpoint sources like suburban runoff from development and open canopy conditions are limiting the quality and diversity of taxa. Quarry Creek near Markell Rd. has a Very Good community and five coldwater taxa collected. However, facultative and tolerant organisms predominated, indicating a threatened and stressed macroinvertebrate community.

Habitat (via Qualitative Habitat Evaluation Index [QHEI])

The East Branch-Chagrin River has, overall, good to excellent habitat, with two tributaries in particular exhibiting near-pristine conditions. Stebbins Gulch (confluence with East Branch at RM 10.6) and an unnamed tributary at RM 10.2 have very clean, nearly silt-free substrates composed of glacial till and sandstone, which is very unusual in Ohio streams. Stebbins Gulch has some of the coldest recorded water temperatures of all the tributaries

sampled, with 14.0C measured during sampling in July 2004. Permanent protection under conservation easement or other measure is strongly recommended for these two tributaries. Other tributaries and the East Branch mainstem exhibit good to excellent habitat, but do show some degree of anthropogenic stress, in particular sedimentation. Pierson Creek is noted as having an unusually large bedload of sand and gravel, and the East Branch mainstem downstream of US Route 6 is out of equilibrium and eroding from the legacy effects of gravel mining operations upstream. Bridge crossings at tributaries and the East Branch mainstem along Heath Road and Sperry Road are fish passage barriers and contribute to higher water temperatures in these reaches.

The below table is a summary of QHEI attributes that were documented by Ohio EPA during their comprehensive sampling for the Chagrin River TSD (2006). It shows the most common habitat impairments are fair to poor development and a high to moderate substrate and riffle embeddedness, indicative of sedimentation from streambank erosion and instability from habitat and flow alterations. All sites sampled had at least a Good (60 or greater) score for QHEI with the exception of the Quarry Creek tributary which scored a QHEI of 55 due to lack of riparian cover and shallow stream depth in addition to fair/poor development and high/moderate embeddedness in both substrate and riffles.

Key QHEI	WWH Attributes														MWH Attributes														Total M.I. MWH Attributes (MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio							
	Components														High Influence							Moderate Influence															
River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	MaxDepth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	MaxDepth < 40 cm (WD, HW)	Total H.I. MWH Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod Riffle Embeddedness	No Riffle						
<i>(15-002) East Branch-Chagrin River</i>																																					
16.3	76.0	34.48	☐	☐		☐	☐	☐	☐	☐	☐	☐	8						0													●			2	0.11	0.33
10.3	70.0	18.52	☐	☐		☐	☐	☐	☐	☐	☐	☐	7						0													●			3	0.13	0.50
2.4	76.0	10.87	☐	☐		☐	☐	☐	☐	☐	☐	☐	9						0													●			2	0.10	0.30
<i>(15-031) Quarry Creek</i>																																					
0.1	55.0	38.46	☐			☐		☐	☐	☐	☐	☐	5				◇	◇	2													●			3	0.50	1.00
<i>(15-032) Stony Brook</i>																																					
0.1	65.5	83.33	☐	☐		☐	☐	☐	☐	☐	☐	☐	8						0													●			1	0.11	0.22
<i>(15-033) Pierson Creek</i>																																					
0.1	66.5	111.1	☐			☐	☐	☐	☐	☐	☐	☐	8						0													●			2	0.11	0.33
<i>(15-038) Trib. to E. Br. Chagrin R. (RM 10.12)</i>																																					
0.1	78.0	76.92	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	10						0																0	0.09	0.09
<i>(15-039) Trib. to E. Br. Chagrin R. (RM 10.60)</i>																																					
0.2	68.5	76.92	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	10						0													●			1	0.09	0.18
<i>(15-040) Trib. to E. Br. Chagrin R. (RM 14.62)</i>																																					
0.1	62.5	66.67	☐	☐		☐	☐	☐	☐	☐	☐	☐	8						0													●			1	0.11	0.22
<i>(15-041) Trib. to E. Br. Chagrin R. (RM 14.80)</i>																																					
0.1	63.5	47.62	☐	☐		☐	☐	☐	☐	☐	☐	☐	6						0													●		●	4	0.14	0.71
<i>(15-042) Trib. to E. Br. Chagrin R. (RM 15.35)</i>																																					
0.2	77.5	40.00	☐	☐		☐	☐	☐	☐	☐	☐	☐	8						0													●		●	3	0.11	0.44
<i>(15-043) Trib. to E. Br. Chagrin R. (RM 16.20)</i>																																					
0.1	77.5	37.04	☐	☐		☐	☐	☐	☐	☐	☐	☐	9						0													●			1	0.10	0.20

Figure 17. QHEI attributes for OEPA sites sampled within the East Branch-Chagrin River HUC-12. Attributes are indicated as presence/absence with a symbol within each respective category.

2.3 Summary of HUC-12 Pollution Causes and Associated Sources

The East Branch-Chagrin River HUC-12 is impacted by suburban development, associated riparian removal, dredge mining, and small sediment dams. Sand bedload, some embeddedness, and thermal temperature increases in downstream reaches have been related to these habitat and flow alterations. It has also been noted by Ohio EPA that modification of some bridge structures is needed to allow fish migration upstream in several East Branch-Chagrin River tributaries (Chagrin River TSD, 2006, p. 15). The East Branch of the Chagrin River has historically been impacted by gravel harvesting from the river, which starves the downstream areas of adequate sediment flow and causes stream bank erosion.

Table 13: Causes and sources of impairment in the East Branch-Chagrin River HUC-12 (Ohio EPA Integrated Report, 2016)

Causes of Impairment	Sources of Impairment
Thermal modifications	Urban runoff/storm sewers (NPS)*
Siltation	Source unknown
Organic enrichment/DO	Land development/suburbanization*
Nutrients	Flow regulation/modification*
Flow alteration	Dredge mining
Direct habitat alterations	Channel erosion/incision from upstream hydromodifications*

* Sources related to nonpoint source pollution

Table 14: Causes and sources at selected sites in East Branch-Chagrin River HUC-12 (Chagrin TSD, 2006)

Site	Causes	Sources
East Branch Chagrin River RM 2.4 Upst. Markell Rd. Non-attainment CWH (2004)	Thermal modifications Direct habitat alterations Flow alteration Sedimentation	Dredge mining Dams Removal of riparian vegetation* Suburban development*
Stoney Brook Trib to E. Br. Chagrin R. @RM 3.57 Kirtland Chardon Rd. (SR 615) Partial attainment CWH (2004)	Thermal modification Nutrients Flow alteration Habitat alteration	Removal of wooded riparian vegetation* Suburban NPS storm water runoff* Suburbanization* Package plants Onsite septic tanks or HSTS*
Trib. to E. Br. Chagrin R. at RM 14.62 (east side trib.) (Harris Cr.) Heath Rd. Partial attainment CWH (2004)	Habitat alteration	Bridge construction (fish barrier) Some removal of riparian vegetation*
Trib. to E. Br. Chagrin R. @RM 14.80 (west side trib.) Sperry Rd. Partial attainment CWH (2004)	Habitat alteration Flow alteration Sedimentation	Dam / bridge construction Riparian vegetation removal* Suburban NPS storm water runoff
Trib. to E. Br. Chagrin River @ RM 15.35 (west side trib.)	Habitat alteration Flow alteration	Road construction (bridge fish barrier) Riparian vegetation removal*

Sperry Rd. Partial attainment CWH / Full EWH (2004)	Sedimentation	Suburban NPS stormwater runoff*
--	---------------	---------------------------------

*Sources related to nonpoint source pollution

Because the East Branch has a steep gradient and naturally erodible soils, sedimentation problems are expected to continue and potentially increase due to development and increases in impervious cover. Potential projects to address these problems and maintain the quality of the East Branch-Chagrin River HUC-12 may include stream restoration projects to restore floodplain access and provide shading, livestock exclusion in upper reaches of the Pierson Creek subwatershed, removal of barriers near Heath Road, and investigation and replacement of failing HSTS. Modifications near road and bridge crossings to improve fish migration would assist in attaining water quality standards (Chagrin River WAP 2011, p. 78).

Chagrin River Watershed Partners has made progress in addressing causes and sources of impairment in the East Branch-Chagrin River HUC-12. In 2005, Holden Arboretum purchased 50 acres along Wisner Road, north of Kirtland-Chardon Road. The property includes a mix of natural areas and farm buildings and supports an ongoing horse stable operation. Nearly a half mile of the State Scenic East Branch of the Chagrin River flows through the property. Previous owners developed a 385-foot-long and 10-foot-tall earthen levee that prevented the river from accessing a 3-acre floodplain. Two small streams to the East Branch were channelized and modified by past land uses. In 2013, Holden Arboretum worked with The Chagrin River Watershed Partners and Lake Soil and Water Conservation District to select and hire a contractor to remove the levee, restore an accessible floodplain, restore a headwater stream and stabilize a second headwater stream. After earthwork was completed Holden Arboretum staff planted thousands of tree and shrub species to ensure this floodplain is stable and provides a wide range of water quality and flood management functions. This project was funded in part by Ohio EPA through their Section 319 program.



Figure 18: Before restoration at Holden Arboretum: 10-foot-tall levee blocked floodplain access



Figure 19: Post-restoration at Holden Arboretum: restored East Branch streambank

Holden Arboretum also received funding from Ohio EPA's Section 319 program to restore 350 linear feet of headwater stream that flows from the outlet of Heath Pond and ultimately to Pierson Creek. The stream is in the rhododendron gardens just downstream of Heath Pond. The restoration created 415 linear feet of meandering stream channel with floodplain access and a modified outfall from Heath Pond. This restoration project protects Pierson Creek by reducing streambank erosion, replanting the stream corridor and maintaining cool water temperatures.



Figure 20: Pre-restoration: Holden Arboretum's headwater stream to Pierson Creek



Figure 21: Post-restoration: Holden Arboretum's headwater stream to Pierson Creek

2.4 Additional Information for Determining Critical Areas and Developing Implementation Strategies

1. Sunnybrook Preserve Biological Assessment and Management Plan. This plan was prepared by Paul J. Pira, Park Biologist at Geauga Park District, in March 2007. The objective of this park management plan is to provide baseline biological and ecological data that will enable Geauga Park District to protect and manage the natural resources of Sunnybrook Preserve. This document is used as a guideline and incorporated into the wise development, maintenance, and future monitoring of the preserve.

Chapter 3: Critical Area Conditions & Restoration Strategies

3.1 Overview of Critical Areas

The following critical areas have been identified for the East Branch-Chagrin River HUC-12:

- Critical Area 1: Riparian Zone Improvements
- Critical Area 2: Addressing Direct Habitat Alterations
- Critical Area 3: Urban Runoff Reduction

The East Branch-Chagrin River is a unique HUC-12 in that all of its streams are designated by the Ohio EPA with a CWH or CWH/EWH aquatic life use. This HUC-12 also includes state designated Scenic River (East Branch RM 15.0 to the mouth), and Outstanding State Waters (designated by Ohio EPA for East Branch RM 14.49 to the mouth). The East Branch HUC-12 benefits from overall high forest cover, low impervious cover, and land protection efforts. However, sections of this HUC-12 are suffering from impairment and have been significantly degraded or are at risk. The East Branch's most downstream sampling site (RM 2.4) is in nonattainment and the reach from this site to the confluence is also considered to be in nonattainment, with causes of impairment including thermal modifications, direct habitat alterations, flow alterations, and sedimentation (*Chagrin River TSD*, 2006). Further, three additional East Branch sites upstream from this reach and several tributaries are only in partial attainment of their ALU designations. Projects that address the causes and sources of impairment must be undertaken to restore the partially or non-attaining sites within the East Branch-Chagrin River HUC-12.

Critical areas have been developed to address high priority nonpoint sources of pollution impairing this coldwater HUC-12. Stream sedimentation due to streambank erosion is a major problem in this HUC-12 due to highly erodible soils and steep stream gradients. Subsequently, the East Branch is very sensitive to any changes in stream hydrology that may be caused by changes in runoff, climatic changes, and changes in land use. Additionally, riparian areas that lack adequate riparian vegetation contribute to streambank instability and stream sedimentation. Critical Area 1 will address riparian zone improvements that will decrease stream sedimentation and improve physical and biological conditions on-site and to downstream reaches. The strategies recommended for Critical Area 1 include bio-engineered streambank stabilization and riparian reforestation.

Direct habitat alterations, including barriers to fish passage, have also been identified as a source of impairment for this HUC-12. These barriers include check dams, concrete dam aprons, culverts, bridges, and other structures that prevent migration of fish to upstream reaches and raise water temperatures (*Chagrin River TSD* 2006, p. 81). Other direct habitat alterations include in-stream structures that impede natural flow and contribute to bank instability and changes to stream pattern and profile. Critical Area 2 will address direct habitat alterations and fish passage improvements that would restore biological conditions for upstream reaches and impaired sites. Restoration strategies recommended for Critical Area 2 include removal or modification of structures to allow fish passage and natural channel design to address other forms of habitat alteration.

Urban runoff from developed areas contributes to degraded water quality, increased sedimentation, and altered hydrology within the East Branch Chagrin River. Critical Area 3 includes the reduction of urban stormwater pollutants through best management practices (BMPs), such as green infrastructure and riparian restoration, which will enhance aquatic habitat and water quality.

The first iteration of the East Branch-Chagrin River HUC-12 NPS-IS will address Critical Areas 1, 2 and 3 as priority projects. Characterizations and projects are being developed for future critical areas that will be included in subsequent updates to this NPS-IS.

3.2 Critical Area 1: Conditions, Goals & Objectives for Riparian Zone Improvements in the East Branch-Chagrin River HUC-12

3.2.1 Detailed Characterization

Critical Area 1 includes the riparian corridor (120 feet each side) of the East Branch from RM 0.0 – 21.9, the riparian corridors (75 feet each side) of partially attaining CWH and CWH/EWH tributaries, and other impaired stream corridors identified by CRWP and partners as needing restoration and improvement. Using CRWP’s model riparian setback, streams draining 20 square miles or more should be protected with a 120 foot buffer on either side and streams draining more than a half square mile to 20 square miles should be protected with a 75 foot vegetated buffer. Identified nonpoint sources for this critical area from the Chagrin River TSD (2006) and 2016 Integrated Assessment Report include urban runoff/storm sewers, flow regulation/modification, land development/suburbanization, and erosion/incision from loss of riparian cover.

Several locations within this HUC-12 are not fully attaining their CWH or CWH/EWH aquatic life use designation and are contributing to the nonattainment of the East Branch at RM 2.4 and downstream to the confluence of the East Branch with the mainstem of the Chagrin River. Sedimentation has been identified as a major cause of impairment at many of these locations based on Ohio EPA sampling. Common sources of sedimentation include removal of riparian vegetation and subsequent streambank erosion. In-stream channel erosion and landslides, both of which occur in this HUC-12, can be a significant contributor of stream TSS loadings (Nelson and Booth, 2002). CRWP has identified widespread streambank erosion in this HUC-12 through landowner site visits, project scoping with member communities, and other field assessments. The *Total Maximum Daily Loads for the Chagrin River (TMDL)* notes the need for substantial reductions in total suspended solids to the East Branch. The TMDL includes recommended load reductions for total suspended solids (TSS) and specific TSS targets for the Chagrin River watershed.

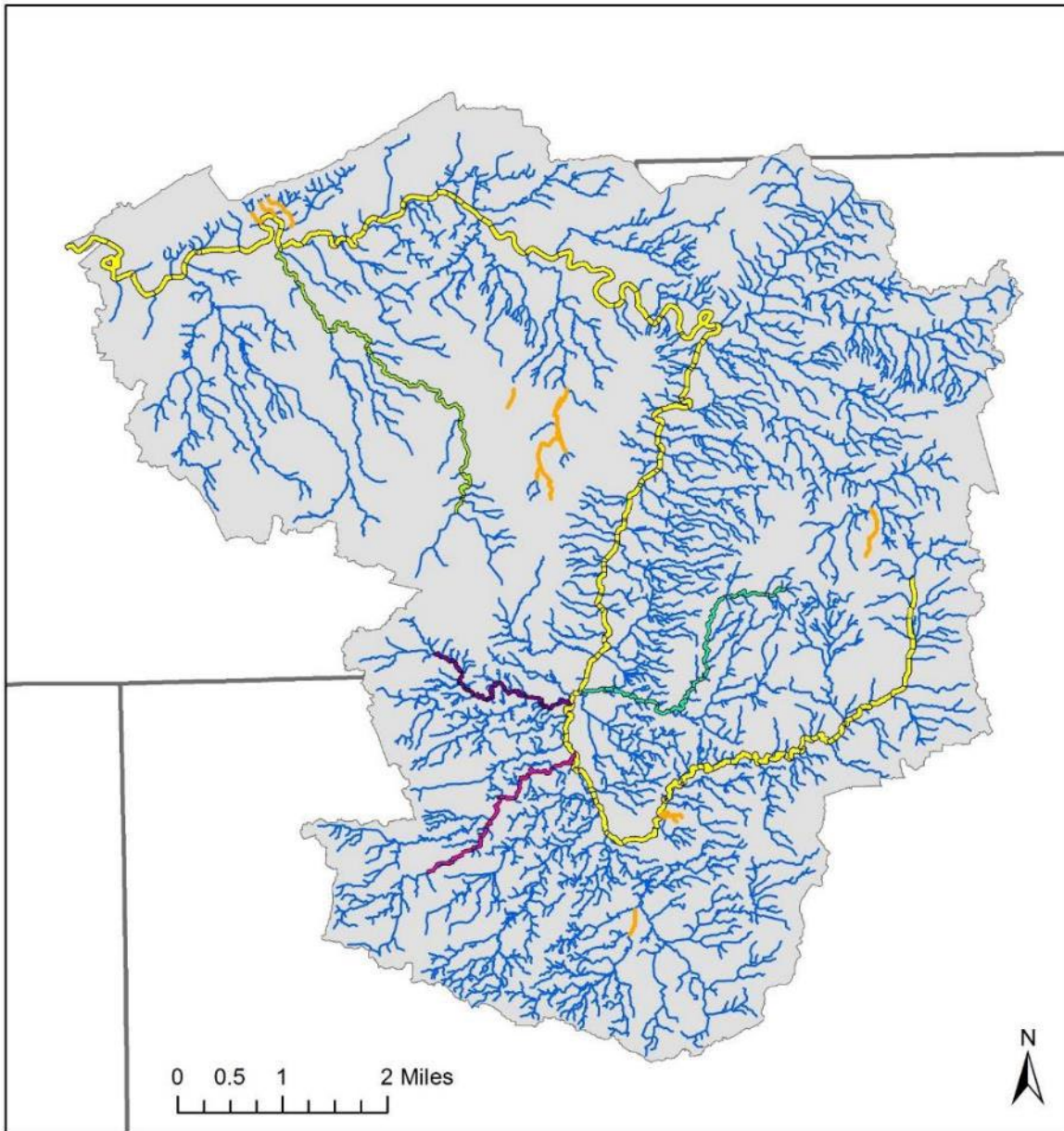
Table 15: Total suspended solids (TSS) load reductions needed for East Branch based on load duration curve analysis (Chagrin TMDL)

	High Flows	Moist Conditions			Mid-Range Flows		Dry Conditions			Low Flows
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Flow exceedance ranges										
East Branch RM 2.4	No Data	0%	83%	0%	No Data	No Data	0%	86%	73%	13%
East Branch RM 10.3	No Data	0%	91%	0%	No Data	No Data	0%	67%	61%	13%

Table 16: Chagrin River watershed targets for total suspended solids (TSS) concentration (mg/L) for high and base flow conditions (Chagrin TMDL)

Drainage Area	High Flow Target	Base Flow Target
Headwaters (< 20 square miles)	17 mg/L	5 mg/L
Wadable (20 < 200 square miles)	53 mg/L	5 mg/L
Small Rivers (200 < 1000 square miles)	70 mg/L	5 mg/L

Removal of riparian vegetation can also contribute to increased stream water temperatures. This is especially important for this coldwater HUC-12. Stream temperature sampling conducted by Ohio EPA in 2003 – 2004 indicated an average 2.89°C increase in temperature from the most upstream site on the East Branch (RM 14.50) to the most downstream site (RM 2.35). Loss of riparian cover at downstream reaches of the East Branch was identified as a potential reason for this temperature increase (*Chagrin River TSD* 2006, p. 69). The East Branch subwatershed is the least developed of the Chagrin River's 12-digit HUC watersheds, but it is also experiencing development pressures in the upper reaches of the watershed and encroachment on headwater streams, resulting in riparian vegetation removal (*Chagrin River WAP* 2011, p. 75).



Legend

- | | |
|---|--|
| UT to East Branch at RM 15.35 | East Branch HUC-12 Streams |
| UT to East Branch at RM 14.80 | East Branch HUC-12 |
| Harris Creek | Ohio Counties |
| Stoney Brook | |
| East Branch mainstem RM 0.0 - 21.9 | |

Figure 22: Map of Critical Area 1. Unassessed sites identified by CRWP and partners are highlighted in orange.

No Ohio EPA numerical criteria is available for CWH. However, the Chagrin River TMDL outlines temperature targets for coldwater habitat. Monthly maximum and monthly average coldwater temperatures are set based on temperature data gathered by ODNR through placement of instream sensors. Both targets are applied to streams designated as CWH in the Chagrin River watershed (OAC 3745-1-22). Critical Area 1 currently has no baseline temperature data, but future monitoring efforts should take temperature into account as a method for showing

CWH improvements. The TMDL notes protection of riparian zones plays a key role in stream integrity and that small streams can maintain their thermal regimes with riparian protection. Riparian setbacks and maintaining riparian cover are recommended for promoting riparian protection and restoration (Chagrin River TMDL 2007, p. 113-114).

Site Specific Conditions

East Branch RM 2.4 and downstream to the mouth

East Branch RM 2.4 is in nonattainment of its CWH ALU designation. Soft sandy substrates, low riffle stability, and less diverse habitat (little definition between runs and pools) were also noted at this site. Only two coldwater taxa were observed at this site during 2003 – 2004 sampling; however, a very good macroinvertebrate community with sensitive EPT taxa was noted. Riparian zone improvements are recommended for the lower reaches of the East Branch to stabilize and improve biological communities and coldwater attributes (Chagrin River TSD, p. 137).

The East Branch downstream of RM 2.4 to the mouth has significant streambank erosion along this reach and at the confluence of the East Branch and mainstem of the Chagrin River. For example, in 2009, CRWP observed streambank erosion and a lack of woody riparian vegetation on the East Branch at approximately RM 1.8 at the Kirtland County Club. In 2018, a Rosgen (2001) Bank Erosion Hazard Index (BEHI) assessment near the confluence of the East Branch and the mainstem of the Chagrin River indicated a score of 38 (High) with Very High Near Bank Stress. A QHEI assessment at this location in 2018 indicated a score of 68.5 (“Good” narrative rating), which is below the QHEI target for this HUC-12’s ALU attainment status. Erosion at this location also threatens the full attainment of WWH at downstream locations on the Chagrin River, including at RM 4.95.



Figure 23: Streambank erosion and material deposition at the confluence of the East Branch with the mainstem of the Chagrin River. (CRWP, July 2013)



Figure 24: Streambank erosion along the East Branch near its mouth (facing left bank downstream). (City of Willoughby, May 2012)



Figure 25: The East Branch at RM 2.4. Erosion is evident on the streambanks. (CRWP, January 2017)



Figure 26: Material deposition due to streambank instability can be observed for lower reaches of the East Branch (showing approximately RM 2.2 on the far right of image to the East Branch mouth on the far left of image). (Google Earth, June 2016)

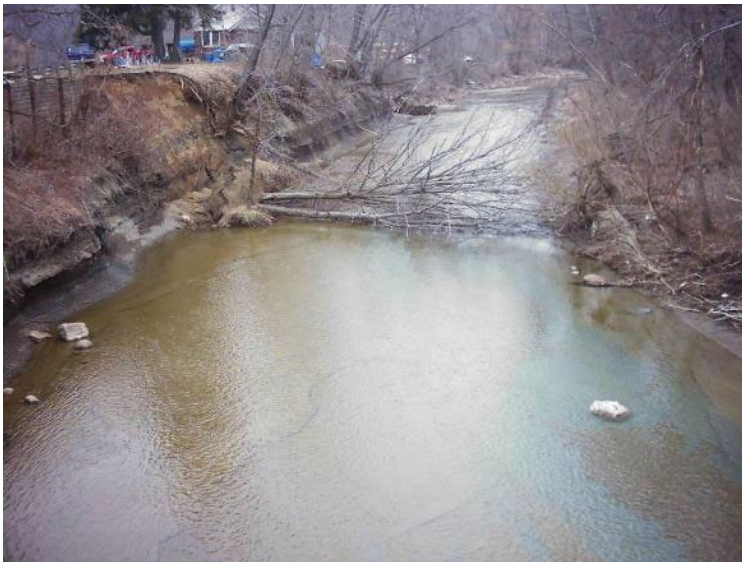


Figure 27: Streambank erosion (left bank downstream) along East Branch RM 3.5 (facing downstream from State Route 615 bridge). (CRWP, March 2009)

East Branch RM 4.3 – 16.3

Ohio EPA sampling in 2007 indicated that the East Branch is in partial attainment of its CWH ALU designation at RM 4.3 and RM 5.1. Unauthorized stream channel alterations at East Branch RM 5.1 resulted in nonattainment of CWH (QHEI and IBI fish diversity impairments) at these sites due to habitat modification and disturbance. These impacts caused channel headcuts and widening as the stream adjusts its floodplain to its new elevation. The impacts of these headcuts were also evident in upstream tributaries, including the mouth of Pierson Creek. No coldwater indicator fish species were present during this 2007 sampling. This sampling occurred prior to the completion of mitigation required for these impacts, partially completed in 2013 (Anderson and Keitz 2007).

Ohio EPA sampling in 2007 also indicated that the East Branch at RM 5.1 and 6.68 is in partial attainment of its CWH ALU designation, and the East Branch from RM 10.3 – 16.3 is in partial attainment of its CWH ALU designation (*Ohio EPA Integrated Report 2016; Chagrin River WAP 2011*). Severe streambank erosion is occurring along the East Branch at RM 13.2 (just west of Wisner Road in the City of Kirtland). Approximately 275 linear feet of the right bank of the East Branch along Wisner Road is eroding, with bank heights up to 18 feet. Just

downstream of the erosion on this right bank, a point bar is creating a pinch point in the river and causing erosion on approximately 150 feet of the left bank. CRWP staff used the Modified Bank Erosion Hazard Index (BEHI) to evaluate bank erosion at the project site in September 2016. Using this metric, bank erosion hazard scored as “high” on the right bank due to bank material and low root density and “extreme” on the left bank due to bank material, low root depth/bank height, and low root density. Streambank erosion was also observed by CRWP during a landowner site visit on the East Branch at approximately RM 14.7 in April 2012.

The BEHI was modified by Cleveland Metroparks for addressing specific local stream conditions unlike those in Colorado where the BEHI was originally developed. The BEHI is a tool originally developed by David Rosgen as a method of assessing the condition of channel banks and their potential for erosion to inventory stream bank condition over large areas and prioritize efforts for remedial action. The system is based on assigning point values to stream segments, preferably 100 feet in length and/or 2-3 meander lengths, based upon bank metrics including ratio of bank height to bankfull height, ratio of root depth to bank height, root density, surface protection, bank angle, bank materials, and stratification of bank material. It can be used to evaluate the current conditions and quantify reductions in erosion susceptibility that will occur post-restoration. In this critical area, the Cleveland Metroparks’ modified BEHI was used to assess erosion at East Branch RM 13.2.

Table 17: Bank Erosion Hazard Index (BEHI) narrative and numeric ratings

Narrative rating	BEHI range (Rosgen 2001)	Modified BEHI range (Newton and Drenten 2015)
Very Low	5-9.5	4-7.5
Low	10-19.5	7.75-15.5
Moderate	20-29.5	15.75-23.5
High	30-39.5	23.75-31.5
Very High	40-45	31.75-36.5
Extreme	46-50	>36.5



Figure 28: Streambank erosion at approximately East Branch RM 14.7. (CRWP, April 2012)



Figure 29: Streambank erosion (left bank shown) on the East Branch at RM 13.2 in the City of Kirtland. (CRWP, September 2016)

East Branch Tributaries

Stoney Brook (Trib. To E. Br. Chagrin R. @RM 3.57) is a CWH stream in partial attainment. It flows into the East Branch through mainly private park and into open parkland surrounding the East Branch. Stoney Brook's watershed is protected through riparian setback regulations in the City of Kirtland and large areas of open space protected by Lake County Metroparks. However, the riparian corridor in the area is impacted by removal of vegetation in an adjacent utility corridor (CRWP 2008) and this lack of riparian vegetation has contributed to streambank erosion and slumping. Open canopy conditions have also contributed to a macroinvertebrate community with a high relative density of facultative filtering caddisflies and midges (*Chagrin River TSD 2006, p. 139*).



Figure 30: Aerial view of Stoney Brook (approximately RM 0.8) indicating removal of riparian vegetation in a utility corridor (facing north/upstream). (Google Earth, 2016)

Harris Creek (tributary to the East Branch at RM 14.62) is in partial attainment of its CWH ALU designation at RM 0.1. Sampling by OEPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration. Removal of riparian vegetation was listed as a nonpoint source of impairment.

An unnamed tributary to East Branch at RM 14.80 is in partial attainment of its CWH ALU designation at RM 0.1. Sampling by OEPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration, flow

alteration, and sedimentation. Nonpoint sources of impairment were listed as dam/bridge construction, riparian vegetation removal, and suburban nonpoint source stormwater runoff.

An unnamed tributary to East Branch at RM 15.35 is in partial/full attainment of CWH/EWH designation. Sampling by OEPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration, flow alteration, and sedimentation. Suburban nonpoint source stormwater runoff and riparian vegetation removal were included as nonpoint sources of impairment.

3.2.2 Detailed Biological Conditions

The following table summarizes the biological conditions Ohio EPA sampling sites within Critical Area 1 that are impaired by sedimentation or removal of riparian vegetation. Critical Area 1 will address these impairments at these sites and others identified in Section 3.2.1.

Table 18: Biological conditions of Ohio EPA sampling sites within Critical Area 1 that are impaired by sedimentation or removal of riparian vegetation. Departures from EWH numerical criteria are highlighted in orange.

Year	Station Name	Attainment Status	ALU Designation	River Mile	2003/2004 IBI	2003/2004 Miwb	ICI Narrative	2003/2004 QHEI
2004	East Branch ust. Markell Rd.	Non	CWH	2.4	42	8.2	Very Good	76.0
2004	Stoney Brook	Partial	CWH	0.1	40	-	Very Good	65.5
2004	Harris Creek (Tributary to East Branch at RM 14.62)	Partial	CWH	0.1	38	-	Excellent	62.5
2004	Tributary to East Branch at RM 14.80	Partial	CWH	0.1	48	-	Good	63.5
2004	Tributary to East Branch at RM 15.35	Partial/Full	CWH/EWH	0.2	46(ns)	-	Very Good (ns)	72.5

(ns) Indicates nonsignificant departure from biocriteria

The East Branch upstream of Markell Road (RM 2.4) site was assessed in 2004 by Ohio EPA and was determined at that time to be in non-attainment of CWH status. It exhibited slightly higher temperatures (average difference of 1.53°C) from an upstream sampling site at RM 10.2. The substrates were sandier with less riffle stability and the habitat was less diverse with low definition between runs and pools. Loss of riparian corridor and NPS stormwater inputs from the influence of suburbanization were identified as sources of coldwater impairment in this reach, with only two coldwater macroinvertebrate taxa collected out of 17 EPT taxa and 25 sensitive taxa. The overall macroinvertebrate score was Very Good but the relatively low incidence of coldwater-specific macroinvertebrates and absence of coldwater fish species indicates a nonattaining CWH community.

Stoney Brook (Tributary to East Branch Chagrin R. @RM 3.57) was assessed by Ohio EPA in 2004 and determined to be in partial attainment of its CWH use. It met CWH macroinvertebrate criteria with four coldwater taxa collected, but the macroinvertebrate community had a high relative density of facultative filtering caddisflies and *Rheotanytarsus* midges. Channel instability, erosion and bank slumpage was also noted in this reach. A high presence of rocky substrates (fine gravel to rubble with some boulders) helped mitigate the impacts from these issues and the macroinvertebrate community was overall Very Good, with 18 EPT taxa and 24 sensitive taxa, but there were no coldwater fish species noted at this site, indicating a partially attaining coldwater community.

Harris Creek (Tributary to East Branch at RM 14.62) was assessed by Ohio EPA in 2004 and determined to be in partial attainment of its CWH use. It met coldwater macroinvertebrate criteria with 8 coldwater taxa noted, but there were no primary coldwater fish species found. Fish barriers and removal of riparian vegetation was noted as a source of impairment at this site, but the stream is recommended to be Superior High Quality Water under the Antidegradation Rule based on high quality habitat and exceptional macroinvertebrate community quality.

A tributary to East Branch at RM 14.80 was sampled by Ohio EPA in 2004 and determined to be in partial attainment of its CWH use. It met coldwater macroinvertebrate criteria with 7 coldwater taxa noted, but there were no primary coldwater fish species found. This stream indicated a marginally exceptional fish community and macroinvertebrate taxa, including the intolerant caddisfly species *Ceratopsyche slossonae*. Southern redbelly dace, a declining fish species that prefers low turbidity, was noted in this stream. However, riffle and run embeddedness may be contributing to fewer than expected taxa. Fish barriers, suburban NPS stormwater runoff and riparian vegetation removal were noted as specific sources of impairment in this reach. This reach is recommended as Superior High Quality Water under the Antidegradation Rule based on good groundwater flow, presence of a declining fish species, and a marginally exceptional fish community score.

A tributary to the East Branch at RM 15.35 was sampled by Ohio EPA in 2004 and determined to be in partial attainment of its existing CWH designation and in full attainment of a recommended EWH designation. No primary coldwater fish species were found, but the site supported a marginally exceptional fish and diverse macroinvertebrate community with seven coldwater macroinvertebrate species found. A high QHEI of 72.5 was noted, indicating more intact upstream riparian corridors. Suburban NPS stormwater runoff and riparian vegetation removal were also noted as specific sources of impairment in this reach. Based on good groundwater flow and marginally exceptional biological quality, this stream is recommended as Superior High Quality Waters or General High Quality Waters under the Antidegradation Rule.

3.2.3 Detailed Causes and Associated Sources

Critical Area 1 addresses siltation and thermal modification impairments caused by removal of riparian vegetation. Ohio EPA identified removal of riparian vegetation as a source of impairment for the East Branch of the Chagrin River upstream of Markell Road (RM 2.4), Stoney Brook, Harris Creek, UT to East Branch Chagrin River at RM 14.8, and UT to East Branch Chagrin River at RM 15.35 (TSD 2006, p. 18-19). Although not assessed by Ohio EPA, other sites in this HUC-12 that are impaired by removal of riparian vegetation have been identified by CRWP through landowner site visits, project scoping with member communities, and other field assessments.

Stoney Brook (tributary to the East Branch at RM 3.57) is in partial attainment of its CWH ALU designation at RM 0.1. Sampling by Ohio EPA in 2003 – 2004 indicated the causes of impairment at this site as thermal modification, nutrients, flow alteration, and habitat alteration. Nonpoint sources of impairment were listed as removal of wooded riparian vegetation, suburban nonpoint source stormwater runoff, suburbanization, and HSTS.

Harris Creek (tributary to the East Branch at RM 14.62) is in partial attainment of its CWH ALU designation at RM 0.1. Sampling by Ohio EPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration. Removal of riparian vegetation was listed as a nonpoint source of impairment.

An unnamed tributary to East Branch at RM 14.80 is in partial attainment of its CWH ALU designation at RM 0.1. Sampling by Ohio EPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration, flow alteration, and sedimentation. Nonpoint sources of impairment were listed as dam/bridge construction, riparian vegetation removal, and suburban nonpoint source stormwater runoff.

An unnamed tributary to East Branch at RM 15.35 is in partial/full attainment of CWH/EWH designation. Sampling by Ohio EPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration, flow alteration,

and sedimentation. Suburban nonpoint source stormwater runoff and riparian vegetation removal were included as nonpoint sources of impairment.

Riparian restoration and stormwater controls are recommended to stabilize and improve the macroinvertebrate community quality and coldwater attributes in the lower reach of the East Branch-Chagrin River.

3.2.4 Outline of Goals and Objectives for the Critical Area

The overall nonpoint source restoration goals for the NPS-IS plan are to achieve or maintain full attainment of the CWH or CWH/EWH designated aquatic life use for all sampling locations within this HUC-12. Ohio EPA does not set numerical criteria for CWH; attainment of this ALU designation is instead based on the presence of at least one coldwater fish taxa and at least four macroinvertebrate taxa. Therefore, goals have been established to maintain or improve the presence of coldwater taxa at partially or non-attaining sites within this HUC-12.

There are no descriptions of fish or invertebrate taxa available for Ohio EPA assessments beyond monitoring conducted in 2003-2004 for the *Chagrin River TSD* (2006). *Ohio EPA Integrated Report* assessments for this HUC-12 only include numeric scores without narrative descriptions and taxa details. Ohio EPA sampling is scheduled for 2021, and biological assessment will be the ultimate determinant of attainment status. However, assessment and monitoring can more immediately be accomplished using QHEI or a related habitat evaluation such as BEHI as a short-term proxy. CRWP's staff is trained in conducting QHEIs and is capable of conducting post-restoration field assessments. The QHEI was designed to provide an empirical, quantified evaluation of the general lotic macrohabitat characteristics that are important to fish communities. Additional goals for Critical Area 1 are set specifically for QHEI, with the idea that maintaining or improving QHEI scores will facilitate good coldwater fish and macroinvertebrate communities. Restoration efforts such as increasing the riparian buffer zone and the quality of floodplain vegetation, reducing bank erosion, and improving substrate should ultimately help the biotic community.

Goal 1: Maintain count of at least 1 coldwater fish species at East Branch RM 2.4

NOT ACHIEVED: Site currently has 0 coldwater fish species present

Goal 2: Maintain count of at least 4 coldwater macroinvertebrate taxa at East Branch RM 2.4

NOT ACHIEVED: Site currently has 2 coldwater macroinvertebrate taxa present

Goal 3: Maintain QHEI score of ≥ 76.0 at East Branch RM 2.4.

ACHIEVED: Site currently has a QHEI score of 76.0.

Goal 4: Maintain QHEI score of ≥ 68 at East Branch RM 4.3

ACHIEVED: Site currently has a QHEI score of 68.

Goal 5: Maintain QHEI score of ≥ 60 at East Branch RM 5.1

ACHIEVED: Site currently has a QHEI score of 60.

Goal 6: Maintain QHEI score of ≥ 78 at East Branch RM 6.68

ACHIEVED: Site currently has a QHEI score of 78.

Goal 7: Maintain count of at least 1 coldwater fish species at Stoney Brook RM 0.1

NOT ACHIEVED: Site currently has 0 coldwater fish species present

Goal 8: Maintain count of at least 4 coldwater macroinvertebrate taxa at Stoney Brook RM 0.1

ACHIEVED: Site currently has 4 coldwater macroinvertebrate taxa present

- Goal 9:** Maintain QHEI score of ≥ 65.5 at Stoney Brook RM 0.1
ACHIEVED: Site currently has a QHEI score of 65.5
- Goal 10:** Maintain count of at least 1 coldwater fish species at Harris Creek RM 0.1
NOT ACHIEVED: Site currently has 0 coldwater fish species present
- Goal 11:** Maintain count of at least 8 coldwater macroinvertebrate taxa at Harris Creek RM 0.1
ACHIEVED: Site currently has 8 coldwater macroinvertebrate taxa present
- Goal 12:** Maintain QHEI score of ≥ 62.5 at Harris Creek RM 0.1
ACHIEVED: Site currently has a QHEI score of 62.5
- Goal 13:** Maintain count of at least 1 coldwater fish species at tributary to East Branch at RM 14.80
NOT ACHIEVED: Site currently has 0 coldwater fish species present
- Goal 14:** Maintain count of at least 7 coldwater macroinvertebrate taxa at tributary to East Branch at RM 14.80
ACHIEVED: Site currently has 7 coldwater macroinvertebrate taxa present
- Goal 15:** Maintain QHEI score of ≥ 63.5 at tributary to East Branch at RM 14.80
ACHIEVED: Site currently has a QHEI score of 63.5
- Goal 16:** Maintain count of at least 1 coldwater fish species at tributary to East Branch at RM 15.35
NOT ACHIEVED: Site currently has 0 coldwater fish species present
- Goal 17:** Maintain count of at least 7 coldwater macroinvertebrate taxa at tributary to East Branch at RM 15.35
ACHIEVED: Site currently has 7 coldwater macroinvertebrate taxa present
- Goal 18:** Maintain QHEI score of ≥ 72.5 at tributary to East Branch at RM 15.35
ACHIEVED: Site currently has a QHEI score of 72.5
- Goal 19:** Achieve Modified BEHI score of Low (7.75-15.5) or better at East Branch RM 13.1.
NOT ACHIEVED: Highest score along proposed restoration reach currently 37 (Extreme) using Modified BEHI.
- Goal 20:** Maintain IBI score of ≥ 40 at Chagrin River at Willoughby @ Ridge Rd. / State Route 84 at RM 4.95.
ACHIEVED: Site currently has IBI Score of 45.0 (good)
- Goal 21:** Maintain ICI score of ≥ 34 (Good) at Chagrin River at Willoughby @ Ridge Rd. / State Route 84 at RM 4.95.
ACHIEVED: Site currently has a narrative of Good (34-37)
- Goal 22:** Maintain MIWB Score of ≥ 7.9 at Chagrin River at Willoughby @ Ridge Rd. / State Route 84 at RM 4.95.
ACHIEVED: Site currently has a score of 8.73.
- Goal 23:** Maintain QHEI score of ≥ 81.0 at Chagrin River at Willoughby @ Ridge Rd. / State Route 84 at RM 4.95.
ACHIEVED: Site currently has a QHEI score of 81.0

To achieve these goals for Critical Area 1, the following objectives need to be achieved.

Objective 1: Reforest 34.6 acres of riparian buffer.

Objective 2: Restore 6,034 linear feet of eroding streambanks through bioengineered streambank stabilization and natural channel design.

Objective 3: Restore 20 acres of riparian wetland habitat.

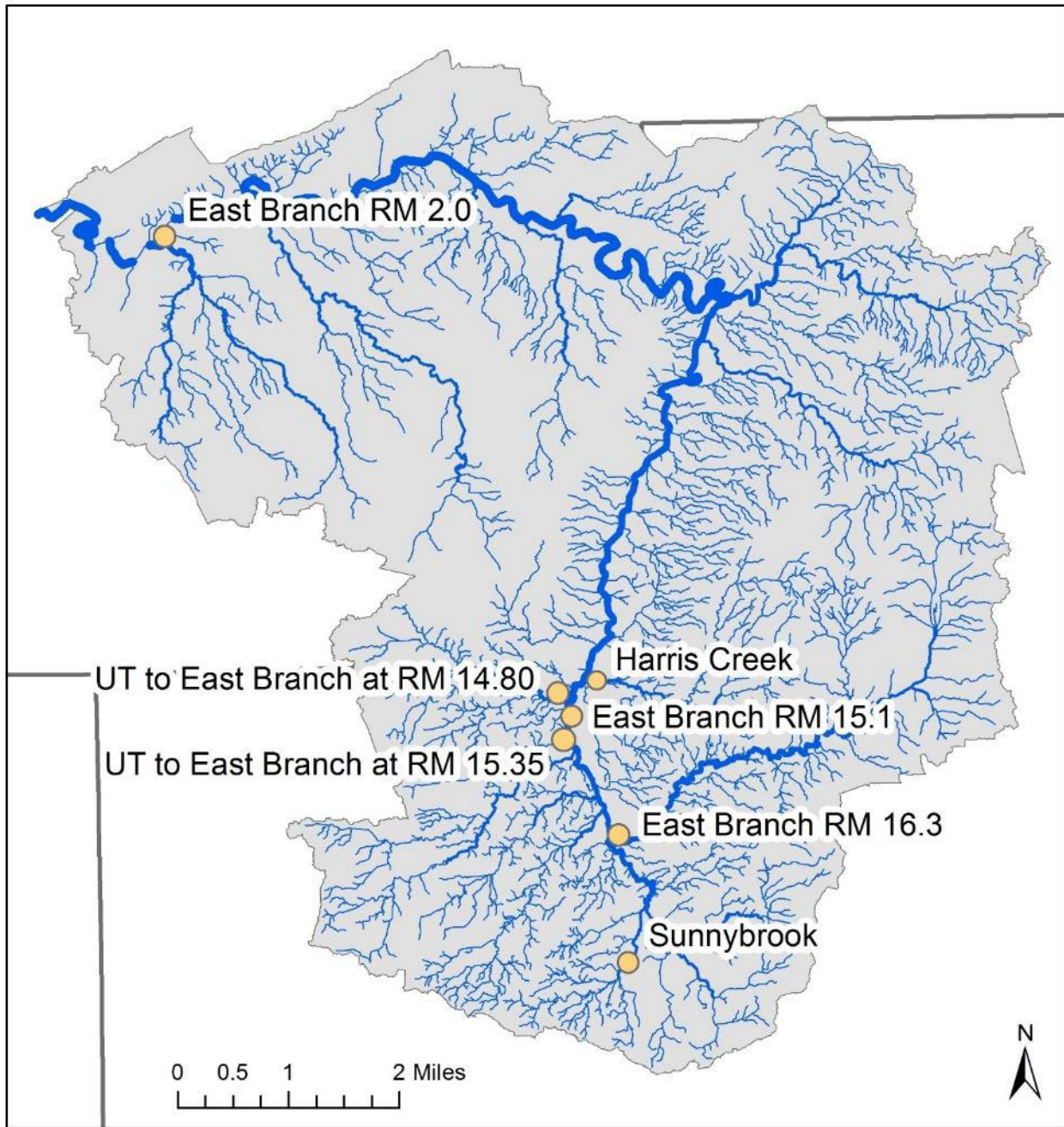
As these objectives are implemented, water quality monitoring (both project related and regularly scheduled monitoring) will be conducted to determine progress toward meeting the identified goals (i.e., water quality standards). These objectives will be reevaluated and modified if determined to be necessary. When reevaluating, CRWP will reference the Ohio EPA Nonpoint Source Management Plan Update (Ohio EPA, 2013), which has a complete listing of all eligible NPS management strategies to consider including:

- Urban Sediment and Nutrient Reduction Strategies
- Altered Stream and Habitat Restoration Strategies
- Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies.

3.3 Critical Area 2: Conditions, Goals & Objectives for Addressing Direct Habitat Alterations in the East Branch-Chagrin River HUC-12

3.3.1 Detailed Characterization

Critical Area 2 includes areas identified by Ohio EPA as impaired by direct habitat alterations, in addition to other areas identified by CRWP and partners as impaired by direct habitat alterations.



Legend

- East Branch HUC-12 Boundary
- Ohio Counties

Figure 31: Map of Critical Area 2. Direct habitat alterations are indicated with an orange dot.

In 2008, the US Fish and Wildlife Service began studying options for creating a low barrier for sea lamprey near the location of the old Daniels Park dam, and examining the efficacy of the Kirtland Country Club Dam as a sea lamprey barrier. The U.S. Fish and Wildlife Service (FWS) completed modeling in 2009 on the historic Daniels Park Dam and the Kirtland Country Club dam on the East Branch of the Chagrin to determine if either dam acted as an effective sea lamprey barrier (Wenck Associates, Inc. 2009). The study indicated that the Daniels Park dam does not act as an effective sea lamprey barrier beyond a one-year flood event (it overtops during 5-10 year storm events) and the dam may impede fish migration across the structure and contribute to nonattainment of the East

Branch upstream (RM 2.4). FWS also noted that the Kirtland Country Club dam is likely not an effective lamprey barrier, however Ohio EPA staff and FWS staff still felt this may be an important structure to maintain as the East Branch of the Chagrin may have good habitat for the invasive lamprey. However, severe erosion has also been observed around the dam abutments, and removal would improve the overall habitat and water quality of this reach of the East Branch. Therefore, the removal of Kirtland Country Club Dam should be explored as a future project for this critical area. Kirtland Country Club, in conversations with CRWP, has indicated a willingness to consider work on a removal project in conjunction with grant funding and may be able to contribute the project with a budgeted cash match. Coordination with Ohio EPA and FWS on project review and approval prior to any implementation would be critical.



Figure 32: A dam on the East Branch at RM 2.0 (Kirtland Country Club) may impede fish migration across the structure and contribute to nonattainment of the East Branch upstream (RM 2.4). (CRWP, 2011)

Harris Creek (tributary to the East Branch at RM 14.62) is in partial attainment of its CWH ALU designation at RM 0.1. Sampling by the Ohio EPA in 2003 – 2004 indicated an exceptional macroinvertebrate community including eight coldwater taxa. However, habitat alteration was causing an impairment in fish community; nonpoint sources of impairment included bridge construction (fish barrier). A timber box structure forms step waterfalls and a plunge pool downstream of the Heath Road bridge, creating a vertical drop that inhibits coldwater fish recolonization and salamander migration to reaches upstream of this structure. Removal of this fish barrier by modifying the structure under the bridge will result in improved fish diversity at this site (*Chagrin River TSD 2006*, p. 28, 138).



Figure 33: The Heath Road bridge over Harris Creek is a fish migration barrier to upper reaches of this tributary.

An unnamed tributary to the East Branch at RM 14.80 is in partial attainment of its CWH ALU designation at RM 0.1. This stream indicated a marginally exceptional fish community and six coldwater macroinvertebrate taxa during Ohio EPA sampling in 2003 – 2004. Southern redbelly dace, a declining fish species that prefers low turbidity, was noted in this stream. The Sperry Road bridge crossing and associated silt trap, installed in the mid-1990s, have been indicated as the source of fish community impairment at this site. Modification of this structure is recommended to allow fish migration to upstream reaches and improve attainment status (*Chagrin River TSD* 2006, p. 29; WAP 2011, p. 78).



Figure 34: The Sperry Road bridge and associated silt trap are barrier to fish migration on an unnamed tributary to the East Branch (tributary enters the East Branch at RM 14.80).

The East Branch at RM 15.1 is affected by a structure downstream of Mulberry Road. As observed during a CRWP landowner visit in 2012, a steel sheet pile dam with a smaller concrete dam below it is a barrier to fish migration at this site.



Figure 35: Sheet pile dam and concrete dam is a fish barrier on the East Branch at RM 15.1

An unnamed tributary to East Branch at RM 15.35 is in partial/full attainment of its CWH/EWH designation. Sampling by Ohio EPA in 2003 – 2004 indicated the causes of impairment at this site as habitat alteration, flow alteration, and sedimentation. Nonpoint sources of impairment included a bridge on Sperry Road with a perched culvert that acts as a barrier to fish migration to upstream portions of this stream. Rip-rap was added to this structure in 2006 – 2007.



Figure 36: Unnamed tributary to East Branch at RM 15.35 is impaired by a perched culvert that acts as a fish barrier.

Sunnybrook (tributary that drains to the East Branch at RM 16.0 and located at Geauga Park District's Sunnybrook Preserve) is exhibiting streambank erosion and siltation due to the effects of damming in the early 20th century. Although the dam has breached, its remnants are still impacting habitat conditions. Sampling of Sunnybrook in 2006 by Geauga Park District indicated good reproducing populations of coldwater species such as redbreast dace (*Clinostomus elongatus*) (Pira 2007). Additional sites impaired by riparian vegetation removal and streambank erosion have also been identified by CRWP through landowner site visits, project scoping with member communities, and other field assessments.



Figure 37: Streambank erosion and siltation on Sunnybrook, a tributary to the East Branch.

The East Branch at RM 16.3 is affected by sheet pile dams at the Heath Road crossing. These dams, installed in approximately 2006, serve as a metal sediment control structure that has filled with a large sand and gravel bedload. Although this structure has decreased bedload movement, it is also an impediment to coldwater fish migration to upper reaches of the East Branch. It is recommended that this fish barrier be removed, in addition to management of stormwater nonpoint source inputs that will help slow erosive forces and bedload movements. The presence of six coldwater macroinvertebrate taxa, including *Sweltsa* (stonefly) and *Glossosoma* (caddisfly), and the presence of other sensitive EPT macroinvertebrate taxa indicate the high quality coldwater attributes of the East Branch at this location (*Chagrin River TSD 2006, p. 137*).

Additional dams in this HUC-12 which also impair fish migration are summarized in the following table:

Table 19: Dams which cause an unknown impairment to fish migration in the East Branch HUC-12

Description	Stream (RM)
Blueberry Pond Dam	Tributary to Pierson Creek
McMillan Lake Dam	Tributary to East Branch at EB RM 10.13
McMillan Pond Dam	Tributary to East Branch at EB RM 10.13
Deep Springs Trout Club Lake Dam	East Branch RM 21.0
Pineway Trails Lake Dam	Tributary to East Branch at EB RM 17.3
Berkshire Hills Lake Dam	Tributary to East Branch at EB RM 16.2
Earthen dam and spillway	Tributary to East Branch at EB RM 16.2
Shadow Hill Lake Dam	Tributary to East Branch at EB RM 16.2

3.3.2 Detailed Biological Conditions

Ohio EPA sampling data available for Critical Area 2 is summarized in the following table:

Table 20: Biological conditions of Ohio EPA sampling sites within Critical Area 2 that are impaired by fish barriers. Departures from EWH numerical criteria are highlighted in orange.

Year	Station Name	Attainment Status	ALU Designation	River Mile	2003/2004 IBI	2003/2004 ICI	ICI Narrative	2003/2004 QHEI
2004	Harris Creek	Partial	CWH	0.1	38	E	Exceptional	62.5
2004	Trib to EB @ RM 14.80	Partial	CWH	0.1	48	G	Good	63.5
2004	Trib to EB @ RM 15.35	Partial/Full	CWH/EWH	0.2	46 (ns)	VG (ns)	Very Good	72.5

(ns) Indicates nonsignificant departure from biocriteria

3.3.3 Detailed Causes and Associated Sources

Critical Area 2 addresses the habitat alteration and flow alteration causes of partial or non-attainment within this HUC-12. Ohio EPA noted habitat alteration and flow alteration as sources for the East Branch of the Chagrin River at RM 2.4, Harris Creek, UT to East Branch Chagrin River at RM 14.8, and UT to East Branch Chagrin River at RM 15.35 (*Chagrin River TSD 2006*, p. 18-19). Dams and bridge construction are listed as causes of partial or non-attainment at these sites. Although not assessed by Ohio EPA, other sites in this HUC-12 that are impaired by direct habitat alteration have been identified by CRWP through landowner site visits, project scoping with member communities, and other field assessments.

3.3.4 Outline of Goals and Objectives for the Critical Area

Ohio EPA does not set numerical criteria for CWH; attainment of this ALU designation is instead based on the presence of at least one coldwater fish species and at least four macroinvertebrate taxa. Therefore, goals have been established to maintain or improve the presence of coldwater taxa at partially or non-attaining CWH sites within this HUC-12. For dually-designated CWH/EWH sites that are in partial attainment, goals have been developed to improve IBI, MIwb, ICI, and QHEI scores so that these sites can achieve full attainment of the CWH/EWH designated aquatic life use.

Goal 1: Maintain count of at least 1 coldwater fish species at Harris Creek RM 0.1

NOT ACHIEVED: Site currently has 0 coldwater fish species present

Goal 2: Maintain count of at least 8 coldwater macroinvertebrate taxa at Harris Creek RM 0.1

ACHIEVED: Site currently has 8 coldwater macroinvertebrate taxa present

Goal 3: Maintain QHEI score of ≥ 62.5 at Harris Creek RM 0.1

ACHIEVED: Site currently has a QHEI score of 62.5

Goal 4: Maintain count of at least 1 coldwater fish species at tributary to East Branch at RM 14.80

NOT ACHIEVED: Site currently has 0 coldwater fish species present

Goal 5: Maintain count of at least 7 coldwater macroinvertebrate taxa at tributary to East Branch at RM 14.80

ACHIEVED: Site currently has 7 coldwater macroinvertebrate taxa present

Goal 6: Maintain QHEI score of ≥ 63.5 at tributary to East Branch at RM 14.80

ACHIEVED: Site currently has a QHEI score of 63.5

Goal 7: Maintain count of at least 1 coldwater fish species at tributary to East Branch at RM 15.35

NOT ACHIEVED: Site currently has 0 coldwater fish species present

Goal 8: Achieve IBI score of ≥ 50 at tributary to the East Branch at RM 15.35

NOT ACHIEVED: Site currently has an IBI score of 46.

Goal 9: Maintain count of at least 7 coldwater macroinvertebrate taxa at tributary to East Branch at RM 15.35

ACHIEVED: Site currently has 7 coldwater macroinvertebrate taxa present

Goal 10: Protect tributary to the East Branch at RM 15.35 by maintaining ICI narrative of Very Good

ACHIEVED: Site currently has an ICI narrative of Very Good

Goal 11: Maintain QHEI score of ≥ 72.5 at tributary to East Branch at RM 15.35

ACHIEVED: Site currently has a QHEI score of 72.5

Goal 12: Maintain QHEI score of 74.5 or more at Sunnybrook tributary

ACHIEVED: Site currently has a QHEI score of 74.5

Goal 13: Achieve count of at least 1 coldwater fish species at ust. Markell Road RM 2.4 sampling point.

NOT ACHIEVED: Site currently has 0 coldwater fish species present

To achieve these goals for Critical Area 2, the following objectives need to be achieved.

Objective 1: Remove 6 fish barriers.

Objective 2: Restore 1,000 linear feet of in-stream habitat using natural channel design features and principles.

Objective 3: Restore and enhance at least **5,000 linear feet of urban streambanks** using **bioengineering techniques and riparian reforestation** to reduce erosion and improve instream habitat.

Objective 4: Establish at least **10 acres of riparian buffer and wetland retention areas** to filter stormwater runoff and improve floodplain connectivity.

As these objectives are implemented, water quality monitoring (both project related and regularly scheduled monitoring) will be conducted to determine progress toward meeting the identified goals (i.e., water quality standards). These objectives will be reevaluated and modified if determined to be necessary. When reevaluating, CRWP will reference the Ohio EPA Nonpoint Source Management Plan Update (Ohio EPA, 2013), which has a complete listing of all eligible NPS management strategies to consider including:

- Urban Sediment and Nutrient Reduction Strategies
- Altered Stream and Habitat Restoration Strategies
- Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies.

3.4 Critical Area #3: Conditions, Goals & Objectives for Urban Runoff Reduction

3.4.1 Detailed Characterization

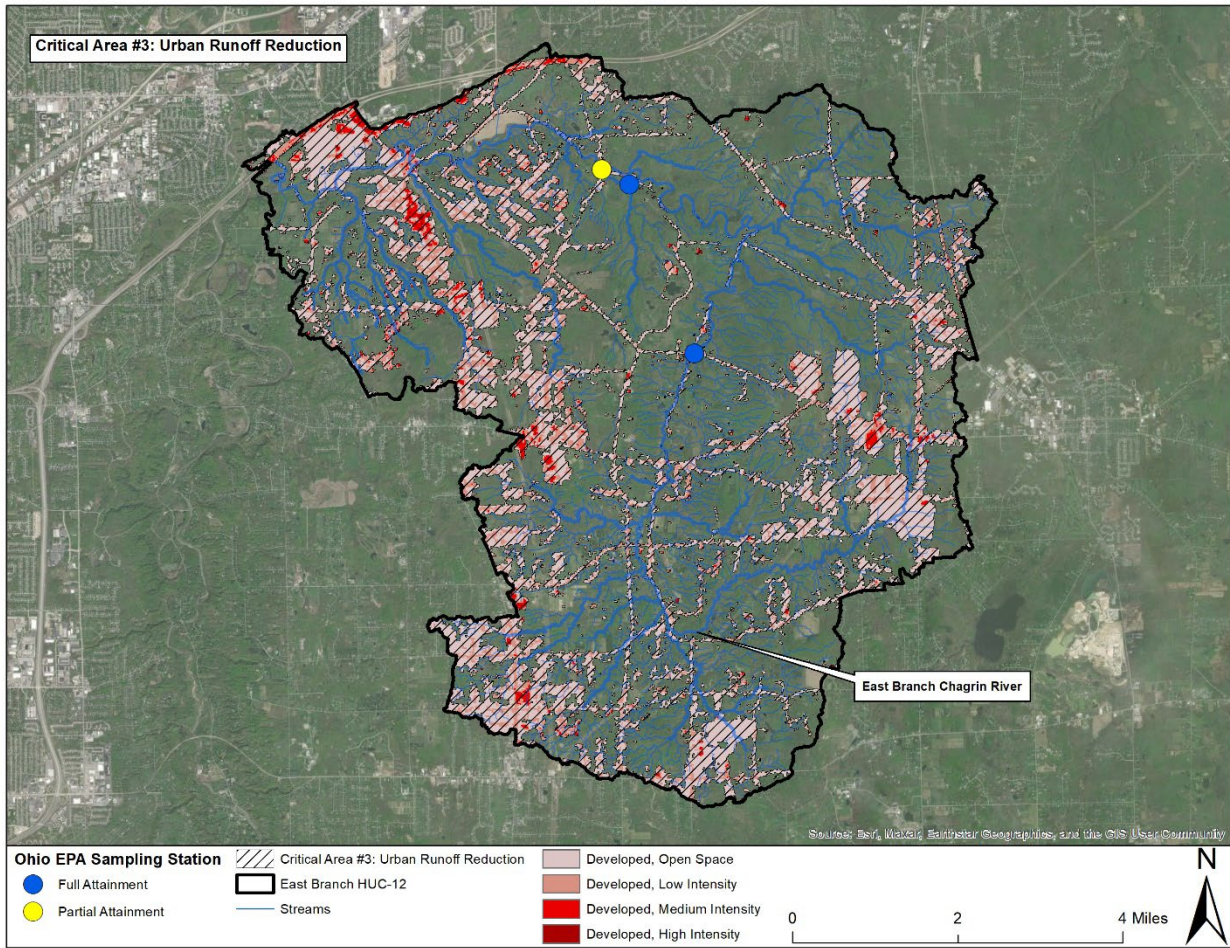
In urban environments, NPS contributions to stormwater runoff can come from a variety of sources, including fertilizers, detergents, leaves and detritus, wild and domesticated animal excrement, lubricants, sediment erosion, and organic and inorganic decomposition processes (Carpenter et. al, 1998; Burton and Pitt, 2001). Urbanization and development often leads to increased pollutant availability, runoff, peak flows, stream “flashiness” and stream instability, along with decreased stream function, storage and retention capabilities and pollutant assimilation in soils (ODNR, 2006). Many of these effects have a direct impact on aquatic life. Degradation to stream ecosystems has been shown even in areas of low amounts of urbanization (5-10% imperviousness) (Schueler, 1994).

Approximately 28% of the East Branch Chagrin River subwatershed is classified as developed land according to the National Land Cover Database (NLCD) (USGS, 2023). Critical Area #3 encompasses the developed land within the subwatershed, including:

- Developed, open space (20%)
- Developed, low intensity (7%)
- Developed, medium intensity (1%)
- Developed, high intensity (<1%)

Urban land use within Critical Area #3 is primarily developed open space, which includes areas with a mixture of impervious surfaces and maintained vegetation, such as lawns and recreational fields. Impervious surfaces in these areas account for less than 20% of total cover. These locations commonly include large-lot single-family housing units, parks, golf courses, and landscaped areas for recreation, erosion control, or aesthetics. Low- and medium-intensity development contributes to increased impervious surfaces, ranging from 20% to 79% cover. High-intensity development, comprising less than 1% of the subwatershed, consists of commercial, industrial, and multi-family residential complexes with impervious surface cover of 80% or greater.

Urban runoff from these developed areas contributes to degraded water quality, increased sedimentation, and altered hydrology within the East Branch Chagrin River. The reduction of urban stormwater pollutants through best management practices (BMPs), such as green infrastructure and riparian restoration, will enhance aquatic habitat and water quality.



3.4.2 Detailed Biological Conditions

Biological data collected by Ohio EPA indicate that portions of the East Branch Chagrin River are experiencing impairment due to urban runoff impacts. The table below summarizes biological conditions at sampling points that coincide with the Urban Runoff Reduction critical area **with** in the East Branch subwatershed.

East Branch-Chagrin River (04110003 04 01)									
Sample Station Name	River Mile	Drainage Area (mi ²)	ALU Type	Fish Sample Year	IBI Score	MIwb Score	Bug Sample Year	ICI Score	QHEI
E. Br. Chagrin R. @ Kirtland Rd.	12.15	22.4	Full CWH	2015	41	8.35	2015	54	76
Pierson Creek Upst. Sperry Rd.	0.4	1.9	Full EWH/CWH	-	N/A	-	2009	- (Very Good)	-
E. Br. Chagrin R. at Kirtland @ Booth Rd.	6.68	36.6	Partial CWH	2007	46	7.57	2007	46	78

The East Branch Chagrin River at RM 6.68 is in partial attainment of its Coldwater Habitat (CWH) designation, with habitat degradation and urban runoff impacts contributing to impairment. Biological indices suggest that sensitive

coldwater species are present, but conditions could be improved with habitat restoration and stormwater management measures.

3.4.3 Detailed Causes and Associated Sources

Urban land use activities contribute to excessive stormwater runoff, which carries sediment, nutrients, and other pollutants into the East Branch Chagrin River. The impervious surfaces within Critical Area #3 **reduce infiltration and increase surface runoff**, which exacerbates streambank erosion, increases sedimentation, and elevates water temperatures. These factors degrade habitat quality and aquatic communities.

Key causes of impairment in Critical Area #3 include:

- **Increased stormwater runoff and altered flow regimes** due to impervious surfaces.
- **Elevated nutrient levels** from fertilizers, pet waste, and organic debris.
- **Sedimentation and streambank erosion** resulting from increased runoff and altered hydrology.
- **Thermal pollution** from heated stormwater runoff.

Sources contributing to these impairments include:

- **Stormwater runoff from urban and suburban developments.**
- **Storm sewers and drainage infrastructure that discharge directly into streams.**
- **Impervious surfaces that reduce infiltration and groundwater recharge.**
- **Erosion from channelized streams and unstable banks.**

Compared with natural land cover, urban development reduces infiltration and evapotranspiration, while increasing surface runoff (USEPA, 2003). Studies have shown that watersheds with as little as 10% impervious surface experience significant increases in runoff volume and pollutant loads (CWP, 1998).

3.4.4 Outline Goals and Objectives for the Critical Area

The overarching goal of this Nonpoint Source Implementation Strategy (NPS-IS) is to reduce the impacts of urban runoff and improve water quality within the East Branch Chagrin River. Urbanization has significantly altered the watershed's hydrology, leading to increased stormwater runoff, higher pollutant loads, and degraded habitat conditions that threaten the river's Coldwater Habitat (CWH) designation. Goals for the East Branch Chagrin River watershed were established based on impervious surface coverage, local hydrology, pollutant loading data, and BMP performance benchmarks. These goals align with Ohio EPA's Total Maximum Daily Load (TMDL) study for the Chagrin River, which identifies sediment and nutrient pollution as key impairments, and the Great Lakes Water Quality Agreement (GLWQA) and Ohio's Domestic Action Plan (DAP), which call for a 40% phosphorus reduction in tributaries to reduce nutrient loading to Lake Erie.

Managing stormwater effectively through green infrastructure and urban best management practices (BMPs) will:

- Enhance aquatic habitat by stabilizing streamflows and improving water quality.
- Reduce sedimentation and erosion, which impair macroinvertebrate and fish communities.
- Mitigate flow alterations that contribute to stream "flashiness" and habitat degradation.
- Reduce stormwater pollutant loads, particularly sediment and phosphorus, which impact coldwater species and downstream water quality.

Goals

To achieve the desired phosphorus reduction from urban land use in the East Branch Chagrin River HUC-12, the following goals have been established:

Goal 1: Reduce urban phosphorus loading contributions in the East Branch Chagrin River watershed to a level that supports water quality standards, targeting a **40% reduction** from estimated baseline levels.

NOT ACHIEVED: Current estimated loads for urban land use types are **63,414 lb/yr of nitrogen, 9,782 lb/yr of phosphorus, and 1,457 ton/yr of sediment** according to U.S. EPA Pollutant Load Estimation Tool (PLET).

Goal 2: Maintain an **IBI score of 41** at the Kirtland Road sampling site (RM 12.15) in the East Branch Chagrin River.

✓ **Achieved:** Current Score: **41** (2015)

Goal 3: Maintain an **MIwb score at or above 7.9** at the Kirtland Road sampling site (RM 12.15) in the East Branch Chagrin River.

✓ **Achieved:** Current Score: **8.35** (2015)

Goal 4: Maintain an **ICI score ≥ 34 (Good to Very Good)** at the Kirtland Road sampling site (RM 12.15) in the East Branch Chagrin River.

✓ **Achieved:** Current Score: **54** (2015)

Goal 5: Maintain a **QHEI score ≥ 70** at the Kirtland Road sampling site (RM 12.15) to support habitat quality.

✓ **Achieved:** Current Score: **76** (2015)

Goal 6: Maintain count of at least **1 coldwater fish species** at the Kirtland Road sampling site (RM 12.15).

✓ **Achieved:** Site has **1 coldwater fish species** present (2015 – Rainbow trout).

Goal 7: Achieve and maintain an **ICI score ≥ 34 (Good to Very Good)** at Pierson Creek upstream of Sperry Road (RM 0.4).

✓ **Achieved:** Current Narrative Score: **"Very Good" (2009)**

Goal 8: Attain count of at least **1 coldwater fish species** at Pierson Creek upstream of Sperry Road (RM 0.4).

NOT ACHIEVED: Site currently has **0 coldwater fish species** present.

Goal 9: Maintain an **IBI score 46** at the Booth Road sampling site (RM 6.68) in the East Branch Chagrin River.

✓ **Achieved:** Current Score: **46** (2007)

Goal 10: Achieve and maintain an **MIwb score at or above 7.9** at the Booth Road sampling site (RM 6.68) in the East Branch Chagrin River.

NOT ACHIEVED: Current Score: **7.57** (2007)

Goal 11: Achieve and maintain an **ICI score ≥ 34 (Good to Very Good)** at the Booth Road sampling site (RM 6.68) in the East Branch Chagrin River.

✓ **Achieved:** Current Score: **46** (2007)

Goal 12: Maintain a **QHEI score ≥ 70** at the Booth Road sampling site (RM 6.68) to support habitat quality.

✓ **Achieved:** Current Score: **78** (2007)

Goal 13: Attain count of at least **1 coldwater fish species** at the Booth Road sampling site (RM 6.68).

✓ **Achieved:** Site has **2 coldwater fish species** present (1990 – Redside dace, 2008 – Rainbow trout).

Objectives

Objective 1: Implement **green infrastructure projects** (such as bioretention basins, rain gardens, permeable pavement, and tree canopy expansion) within **Critical Area #3** to **retain, detain, and/or treat runoff from at least 75 acres** (10 million gallons annually) of urbanized impervious surfaces (e.g., roads, parking lots, rooftops).

Water quality monitoring will be conducted to measure progress toward these goals, including post-project assessments of biological indices (IBI, MIwb, ICI), QHEI scores, and pollutant load reductions. Through an adaptive management process, objectives may be refined or expanded in future updates of the NPS-IS Plan.

The Ohio EPA Nonpoint Source Management Plan Update (Ohio EPA, 2013) will be referenced to evaluate additional strategies, including:

- Urban Sediment and Nutrient Reduction Strategies
- Altered Stream and Habitat Restoration Strategies
- Nonpoint Source Reduction Strategies
- High Quality Waters Protection Strategies

Chapter 4: Projects and Implementation Strategy

4.1 Projects and Implementation Strategy Overview Table

Below are the projects and evaluation needs currently believed to be necessary to remove the impairments to the East Branch-Chagrin River HUC-12 as a result of the identified causes and associated sources of nonpoint source pollution. Because the attainment status is based on biological conditions, it will be necessary to periodically re-evaluate the status of the critical area to determine if the implemented projects are sufficient to achieve restoration. Time is an important factor to consider when measuring project success and overall status. Biological systems in some cases can show response fairly quickly (months); others may take longer (years) to show recovery. There may also be reasons other than nonpoint source pollution for the impairment. Those issues will need to be addressed under different initiatives, authorities or programs which may or may not be accomplished by the same implementers addressing the nonpoint source pollution issues.

The projects described in the Overview Table have been prioritized using the following three step prioritization method:

- Priority 1:** Projects that specifically address one or more of the listed Objectives for the Critical Area.
- Priority 2:** Projects where there is landowner willingness to engage in projects that are designed to address the causes and sources of impairment or where there is an expectation that such potential projects will improve water quality in the East Branch-Chagrin River HUC-12.
- Priority 3:** Input from the public on water quality issues and/or project ideas gathered from a permanent online survey and periodic stakeholder meetings will be evaluated for correlation between known causes and sources and potential for inclusion in the NPS-IS.

For East Branch-Chagrin River HUC-12 (04110003-04-01)

Applicable Critical Area	Goal	Objective	Project #	Project Title (EPA Criteria g)	Lead Organization (criteria d)	Time Frame (EPA Criteria f)	Estimated Cost (EPA Criteria d)	Potential/Actual Funding Source (EPA Criteria d)
Altered Stream and Habitat Restoration Strategies								
1	19	1, 2	1	East Branch Chagrin River Streambank Stabilization Project (RM 13.1)	City of Kirtland; CRWP	1 – 3 years	\$250,000	319
1	1, 2, 3, 4, 5, 6	1, 2	2	East Branch (RM 4.0 – 6.6) Stream Restoration (remaining from dredge mining impacts)	City of Kirtland Hills; CRWP	3 – 7 years	\$750,000	Mitigation funds
2	1	1	3	Fish Passage Project – Harris Creek	Chester Twp; CRWP	3 – 7 years	\$125,000	319; USFWS National Fish Passage Program
2	4	1	4	Fish Passage Project – Trib. to East Branch (RM 14.80)	Chester Twp; CRWP	3 – 7 years	\$125,000	319; USFWS National Fish Passage Program
2	7	1	5	Fish Passage Project – Trib. To East Branch (RM 15.35)	Chester Twp; CRWP	3 – 7 years	\$75,000	319; USFWS National Fish Passage Program
2	12	2	6	Sunnybrook Streambank Stabilization and Riparian Restoration Project	Geauga Park District; CRWP	1 – 3 years	\$200,000	319; WRRSP; GLRI
2	13	1	7	Kirtland Country Club Dam Removal or Modification	CRWP, Kirtland Country Club, City of Willoughby	3 – 7 years	\$350,000	319, Kirtland Country Club, USFWS Fish Passage Program
1	20, 21, 22, 23	2, 3	8	East Branch Confluence Restoration	CRWP, City of Willoughby	1 – 3 years	\$1,105,100	319, WRRSP, GLRI, SOGL, Project Partner Contributions

1	19	1, 2	9	Restoring a Resilient East Branch Chagrin River Corridor (RM 12.6)	City of Kirtland, CRWP, Lake SMD	1 – 3 years	\$297,346	319
2	1, 2, 3	2	10	American-Croatian Lodge Dam Removal and Stream Restoration Project (Phase I)	Munson Township, American-Croatian Lodge, CRWP	1 – 3 years	\$337,000	319, WRRSP, GLRI, Project Partner Contributions
1	20, 21, 22, 23	1, 2, 3	11	East Branch Chagrin River Stream Restoration	CRWP	1 – 3 years	\$327,639.29	319, H2Ohio
3	1, 7, 8	1	12	Cistern Stormwater Management Project	Holden Forests & Gardens	1 – 3 years	\$35,000	319

4.2 Project Summary Sheet(s)

These summary sheets provide the essential nine elements for short-term and/or next step projects that are in development and/or in need of funding. As projects are implemented and new projects developed, these sheets will be updated. Any new summary sheets created will be submitted to the state of Ohio for funding eligibility verification (i.e., all nine elements are included).

Nine Element Criteria	Information needed	Explanation
<i>n/a</i>	Title	East Branch Chagrin River Streambank Stabilization Project
<i>criteria d</i>	Project Lead Organization & Partners	Lead - City of Kirtland; Partners – Chagrin River Watershed Partners, Inc.; Locust Farms, Inc. (landowner); Holden Arboretum (conservation easement holder); Design-Build Consultant (to be selected by competitive bid)
<i>criteria c</i>	HUC-12 and Critical Area	East Branch of the Chagrin River (041100030401), Critical Area 1
<i>criteria c</i>	Location of Project	41.584398, -81.301363
<i>n/a</i>	Which strategy is being addressed by this project?	Stabilize eroding streambanks using bioengineering methods (Goal 2.03.02 from <i>Ohio EPA's Nonpoint Source Management Plan Update</i>)
<i>criteria f</i>	Time Frame	Short-Term (Priority) (July 2017 - December 2018)
<i>criteria g</i>	Short Description	This project will stabilize streambank using bioengineering methods along the East Branch of the Chagrin River in the City of Kirtland, resulting in sediment and nutrient load reductions.
<i>criteria g</i>	Project Narrative	The City of Kirtland will hire a design-build team to stabilize 425 linear feet of streambank using bioengineering methods and plant native woody plants in 0.25 acres of riparian area on the East Branch (RM 13.1). This work will reduce sediment loads, helping to address a downstream siltation impairment (see pp. 46-48 in NPS-IS). This project is located in the City of Kirtland, Lake County, Ohio 2,500 feet north of U.S. Route 6 near Wisner Road. CRWP will assist with grant administration and educational deliverables. Locust Farms (landowner) will consent to project implementation and protecting the site for at least 10 years.
<i>criteria d</i>	Estimated Total cost	\$250,000 (\$150,000 grant & \$100,000 match)
<i>criteria d</i>	Possible Funding Source	Ohio EPA Section 319 Grant

<i>criteria a</i>	Identified Causes and Sources	<p><i>Causes:</i> siltation, thermal modification</p> <p><i>Source:</i> removal of riparian vegetation</p>
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	<p>With the goal being to achieve a Modified BEHI score of Low (10-19.5) or better at East Branch RM 13.1, reasonable objectives are:</p> <ul style="list-style-type: none"> • Objective 1: Reforest 34.6 acres of riparian buffer • Objective 2: Restore 6,034 linear feet of eroding streambanks through bioengineered streambank stabilization and natural channel design.
	Part 2: How much of the needed improvement for the whole Critical Area is <i>estimated</i> to be accomplished by this project?	<ul style="list-style-type: none"> • 0.25 acres of the 34.6 acres of Objective 1 will be met (0.72%) • 425 linear feet of the 6,034 linear feet of Objective 2 will be met (7.04%) <p>Goals: This project is projected to bring this location from a Modified BEHI of Extreme (37) erosion to Low (7.75-15.5) erosion index through restoration of 425 linear feet of eroding bank using natural bioengineering methods, and 0.25 acres of riparian restoration with woody vegetation which will further stabilize the riparian and stream corridor. It is expected that this project will, upon completion, immediately achieve Goal 19.</p>
	Part 3: Load Reduced?	161.8 pounds/year Nitrogen, 80.9 pounds/year Phosphorus, and 80.9 tons/year sediment will be removed as a result of this project.
<i>criteria i</i>	How will the effectiveness of this project in addressing the NPS impairment be measured?	CRWP staff or a qualified contractor will conduct BEHI analysis post-construction. Ohio EPA 319 staff will conduct biological criteria sampling if this project is funded by a Section 319 grant.
<i>criteria e</i>	Information and Education	This project will be used to promote and highlight the importance of reducing runoff, erosion, and sedimentation into the Chagrin River, and educate the public on maintenance of healthy riparian corridor. CRWP will work with Holden Arboretum to develop a project fact sheet and a tour of the completed restoration. CRWP will present on the project at a Board of Directors meeting (averaging 40 local officials and professional advisors per meeting), and will highlight the project in CRWP's annual report and on their website and Facebook page. The target audience will be residents of Kirtland in coordination with the City of Kirtland, but the information will be replicable and widely distributed across other coldwater habitat CRWP member communities and other coldwater watersheds in the Central Lake Erie Basin.

Nine Element Criteria	Information needed	Explanation
<i>n/a</i>	Title	Sunnybrook Streambank Stabilization and Riparian Restoration Project
<i>criteria d</i>	Project Lead Organization & Partners	Lead – Geauga Park District (landowner/land manager); Partners – Chagrin River Watershed Partners, Inc.; Design-Build Consultant (to be selected by competitive bid)
<i>criteria c</i>	HUC-12 and Critical Area	East Branch of the Chagrin River (041100030401), Critical Area 2
<i>criteria c</i>	Location of Project	Sunnybrook Preserve – Geauga Park District 12474 Heath Rd. Chester Twp., Ohio 41.530129, -81.300587
<i>n/a</i>	Which strategy is being addressed by this project?	Stabilize eroding streambanks using bioengineering methods (Goal 2.03.02 from Ohio EPA’s Nonpoint Source Management Plan Update)
<i>criteria f</i>	Time Frame	Short-Term (Priority) (1-3 yr)
<i>criteria g</i>	Short Description	This project will restore in-stream habitat using natural channel design features and principles and stabilize streambanks using bioengineering methods along Sunnybrook, located in Chester Township (Gauga County), resulting in sediment and nutrient load reductions to the East Branch of the Chagrin River.

<p><i>criteria g</i></p>	<p>Project Narrative</p>	<p>Located in Chester Township, Geauga County, Ohio, on Heath Road between Wilson Mills Road and Mayfield Road, Sunnybrook Preserve is an undeveloped and predominantly wooded parcel of land, comprised of 73 acres within the East Branch of the Chagrin River watershed. History of the land indicates that this parcel was used extensively for horticultural purposes throughout the twentieth century. Timber was also taken from the property in 1969. Surrounded by moderately developed landscapes, Sunnybrook Preserve offers a wide variety of wetlands, streams, uplands, and forests which are rich in biological diversity.</p> <p>Sunnybrook Preserve is significant to the mission of Geauga Park District not only to preserve these beautiful parcels of land for future generations but also to conserve the biological diversity and important surface and groundwater functions for the East Branch of the Chagrin River. During the early twentieth century, a log dam was installed on the creek to form a swimming hole. In 1934 the log dam was replaced with a concrete dam and a larch planted on the "island". Crayfish undermined the concrete dam and the pond disappeared overnight in late the 1930's (aerial photos from 1938 do not show the dam). Since that time the area has periodically been inhabited by beavers (most recently (1990's) beavers built a dam and backed up the water once again). In 2005-2006, during routine management plan field work (biological inventories/surveys) a number of rare and sensitive aquatic species were documented by Geauga Park District's Natural Resource Management Department. The Southern Redbelly Dace (<i>Phoxinus erythrogaster</i>) and Redside Dace (<i>Clinostomus elongatus</i>) were both found in Sunnybrook's mainstem in 2006. Since that time, the stream at Sunnybrook Preserve has been negatively impacted and continues to suffer from erosion and siltation issues</p> <p>Currently, this area is now a reverting stream system (was a man-made pond prior to 1938 and beaver impoundments after). It is comprised of approximately 500 linear feet of a coldwater tributary (Sunnybrook) to the Chagrin River. This project will restore approximately 500 feet of in-stream habitat using natural channel design principles and plant 1 acre of riparian area with native woody vegetation. Geauga Park District will hire a design-build team to complete the restoration component of this project. Similarly, the associated riparian wetlands are returning to a more natural state, although they are impacted by invasive plant infestations of <i>Phalaris arundinacea</i>, <i>Phragmites australis</i>, and the European black alder (<i>Alnus glutinosa</i>). Past wetland disturbances include selective cutting, sedimentation, and farming. This area could be further enhanced/restored by allowing the stream better access to the floodplain with additional vernal pool/oxbow wetlands restored and further treatment of the emergent marsh for invasive species. These restored/reconnected wetlands would provide valuable services for the Chagrin River such as attenuating floodwaters, filtering/lessening nutrient loads, reducing siltation, and providing excellent wildlife habitat (Source: Geauga Park District).</p>
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<i>criteria d</i>	Estimated Total cost	<p>Total estimated project cost: \$200,000</p> <p>Grant management and educational outreach: \$8,500</p> <p>Stream restoration (500 linear feet): \$100,000</p> <p>Riparian wetland restoration including invasive species treatment and native plantings (1 acre): \$31,500</p> <p>Design, engineering, and permitting: \$60,000</p> <p>Although a smaller stream, bank instability and resulting sedimentation is significant at this site, with near-vertical eroding banks along much of the reach and slumping evident in many places.</p>
<i>criteria d</i>	Possible Funding Source	Ohio EPA Section 319 Grant; Ohio EPA WRRSP
<i>criteria a</i>	Identified Causes and Sources	<p><i>Causes:</i> habitat alteration, flow alteration</p> <p><i>Sources:</i> dams, bridge construction, other impaired sites identified by CRWP and partners</p>
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	<p>With the goal being to maintain a QHEI of 74.5 or better at Sunnybrook tributary, a reasonable objective is:</p> <ul style="list-style-type: none"> Objective 2: restore 1,000 linear feet of in-stream habitat using natural channel design features and principles.
	Part 2: How much of the needed improvement for the whole Critical Area is <i>estimated</i> to be accomplished by this project?	<p>500 linear feet of the 1,000 linear feet of Objective 2 will be met (50%)</p> <p>Goals: This project is projected to maintain or improve the QHEI of Sunnybrook tributary at 74.5 or better, protecting the existing water quality and preventing degradation of water quality from in-stream habitat impairments. The QHEI target score upon completion of restoration is 78. This may be achieved through enhanced instream and riparian cover and reducing the sedimentation caused by the eroding streambanks.</p>
	Part 3: Load Reduced?	49.0 pounds/year Nitrogen, 24.4 pounds/year Phosphorus, and 24.4 tons/year sediment will be removed as a result of this project.
<i>criteria i</i>	How will the effectiveness of this project in addressing the NPS impairment be measured?	Geauga Park District will conduct post-construction monitoring for this project.

<i>criteria e</i>	Information and Education	This project will be used to promote and highlight the importance of reducing runoff, erosion, and sedimentation into an important stream ecosystem, and educate the public on maintenance of healthy riparian habitat. CRWP will work with Geauga Park District to develop a project fact sheet and a tour of the completed restoration. CRWP will present on the project at a Board of Directors meeting (averaging 40 local officials and professional advisors per meeting) and will highlight the project in CRWP's annual report and on their website and Facebook page. The target audience will be CRWP member communities that have coldwater habitat streams, but the information will be replicable and widely distributed across other coldwater watersheds in the Central Lake Erie Basin.
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Nine Element Criteria	Information needed	Explanation
<i>n/a</i>	Title	East Branch Confluence Restoration
<i>criteria d</i>	Project Lead Organization & Partners	City of Willoughby, Village of Waite Hill Chagrin River Watershed Partners (CRWP), Western Reserve Land Conservancy (WRLC)
<i>criteria c</i>	HUC-12 and Critical Area	HUC 041100030401, East Branch Chagrin River, Critical Area 1
<i>criteria c</i>	Location of Project	41.630110, -81.398814 Daniels Park, 38401 Johnnycake Ridge Rd., Willoughby, OH 44094 RM 0.0 – 0.02
<i>n/a</i>	Which strategy is being addressed by this project?	Altered Stream & Habitat Restoration
<i>criteria f</i>	Time Frame	Short-Term (Priority) (1-3 yr)
<i>criteria g</i>	Short Description	This project will restore the East Branch and riparian wetlands in Willoughby and Waite Hill, Ohio.
<i>criteria g</i>	Project Narrative	This project will restore 700 feet of the East Branch and 0.6 acres of riparian wetlands just south of State Route 84 at the mouth of the East Branch in Willoughby and Waite Hill, Ohio. 950 feet of eroding streambanks with 10.5 feet bank heights are contributing sediment to the river and threatening attainment status in the downstream HUC-12 (Town of Willoughby-Chagrin River, 041100030403). This project will greatly reduce sediment loading and protect downstream attainment status. In June 2018, this site's BEHI (Rosgen 2001) score was High (38) with Very High Near Bank Stress and the site's QHEI score was 68.5 ("Good" narrative). The conceptual plan restores the East Branch by realigning the channel to a more stable configuration and removing the influence of the former water intake structures on the flow hydraulics. Most or part of the old channel will

		<p>become an oxbow wetland. CRWP, the City of Willoughby, and Western Reserve Land Conservancy will collaborate to implement the project.</p> <p>A project sheet is also included in the Griswold Creek-Chagrin River NPS-IS for the Riparian Restoration & Streambank Stabilization at Daniels Park. The restoration plan for the Chagrin River includes stabilizing 685 feet of the eroding western bank of the Chagrin River south of State Route 84 using bioengineering methods and restoring 1.5 acres of riparian vegetation. The native plants will help stabilize the banks and filter runoff before it reaches the river. The restoration approach will likely include bendway weirs, a bankfull bench, and riparian restoration along the western bank with removal of the point bar on the eastern bank and realigning the transverse riffle. The project on the Chagrin River will also contribute to maintaining the attainment status of the Chagrin River downstream in the Town of Willoughby-Chagrin River HUC-12. The Town of Willoughby-Chagrin River NPS-IS is under development by CRWP with funding support from an ODNR Coastal Management Assistance Grant. CRWP held a public meeting in 2018 to gather input and has begun field assessments and project development. The first version of the plan will be completed by December 31, 2019. One of the critical areas addressing eroding streambanks will include a goal of maintaining attainment at Willoughby RM 4.95.</p>
<i>criteria d</i>	Estimated Total cost	\$1,105,100
<i>criteria d</i>	Possible Funding Source	319, WRRSP, GLRI, Sustain Our Great Lakes, Contributions from Project Partners
<i>criteria a</i>	Identified Causes and Sources	<p><i>Causes:</i> habitat alteration, flow alteration, sedimentation</p> <p><i>Sources:</i> dams, removal of riparian vegetation, suburban development</p>
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	<p>The objectives for Critical Area 1 include:</p> <p>Objective 1: Reforest 34.6 acres of riparian buffer</p> <p>Objective 2: Restore 6,034 linear feet of eroding streambanks through bioengineered streambank stabilization and natural channel design.</p> <p>Objective 3: Restore 20 acres of riparian wetlands near the mouth of the East Branch.</p> <p>This project is important for maintaining the Chagrin River's downstream attainment status. The Chagrin River is currently in full attainment of its warmwater aquatic life use at Chagrin R. At Willoughby @ Ridge Rd. (St. Rt. 84), RM 4.95. This project will help maintain or improve the IBI score of 45.0 (Goal 20), the ICI of 34 or better (Goal 21), the MIWB of 8.73 (Goal 22), and the QHEI score of 81.0 (Goal 23). The Chagrin River is also in full attainment at all other downstream assessment points heading North towards Lake Erie, including the Chagrin R. At Willoughby @ Todd Field Restoration Area (RM 4.20), The Chagrin R. At Willoughby, Dst. Mentor Ave. (U.S. Rt. 20) (RM 3.90), The Chagrin R. @ Park Off Reeves Rd (RM 2.72), And Chagrin R. At Eastlake, 0.5 Mi. Upst. Lake Shore Blvd. (RM 1.50). This project is of critical importance for maintaining the attainment of water quality standards downstream. Furthermore, the Chagrin River is considered Seasonal Salmonid Habitat (capable of supporting salmonids from October to May) and is a highly popular fishing destination, with stream fishing available at Daniel's Park, Todd Field off Route 20, and Gilson Park off Lost Nation Road. The Ohio DNR Division of Wildlife stocks steelhead yearly.</p>
	Part 2: How much of the needed improvement for the whole Critical Area is	<ul style="list-style-type: none"> • 950 feet of the 6,034 linear feet of Objective 2 will be met (16%) • 0.6 acres of the 20 acres of Objective 3 will be met (3%)

	<i>estimated to be accomplished by this project?</i>	There is a recognition that there is a lag time associated with nonpoint source-related projects and measured stream response. With respect to the Goals for Critical Area 1, QHEI will be the main driver as that will dictate the habitability of fish and macroinvertebrates. It is expected that the restoration project will improve QHEI from 68.5 to 82.0 or better with a year of restoration by reducing bank erosion and improving instream vegetative cover. This project will also maintain or improve the QHEI Score at RM 4.95, currently scoring 81.0, with maintenance or incremental increases in the IBI, MIWB, and ICI scores for the next several years thereafter.
	Part 3: Load Reduced?	274.7 tons sediment/yr., 329.6 lbs. P/yr., 714.1 lbs. N/yr.
<i>criteria i</i>	How will the effectiveness of this project in addressing the NPS impairment be measured?	CRWP or the implementation consultant will conduct post-construction BEHI assessments. If the project is funded through the Ohio EPA 319 program, staff from the OEPA-DSW Ecological Assessment Unit will perform both pre- and post-project monitoring. Ohio EPA will monitor the project site as well as the sampling station at Chagrin River RM 4.95 in the "Willoughby-Chagrin River" HUC-12 downstream of the "East-Branch- Chagrin River" HUC-12.
<i>criteria e</i>	Information and Education	Project information will be shared with the public and other potential implementors of stream restoration projects through outreach mechanisms including an educational project sign, two websites, a presentation at the CRWP Board of Directors meeting, and one fact sheet. There will be a post-restoration tour of the project site and the project will also be highlighted in CRWP's annual report.

Nine Element Criteria	Information needed	Explanation
<i>n/a</i>	Title	Restoring a Resilient East Branch Chagrin River Corridor
<i>criteria d</i>	Project Lead Organization & Partners	City of Kirtland, Chagrin River Watershed Partners, Lake County Stormwater Management Department.
<i>criteria c</i>	HUC-12 and Critical Area	East Branch of the Chagrin River (041100030401), Critical Area 1
<i>criteria c</i>	Location of Project	41.590401, -81.298397
<i>n/a</i>	Which strategy is being addressed by this project?	Stabilize eroding streambanks using bioengineering methods (Goal 2.03.02 from Ohio EPA's Nonpoint Source Management Plan Update)
<i>criteria f</i>	Time Frame	Short-Term (Priority) (1-3 yr)
<i>criteria g</i>	Short Description	This project will stabilize streambank using bioengineering methods along the East Branch of the Chagrin River in the City of Kirtland, resulting in sediment and nutrient load reductions.
<i>criteria g</i>	Project Narrative	The City of Kirtland will hire a design-build team to stabilize 425 linear feet of streambank using bioengineering methods and restore existing floodplain (native plant installation and grading as needed) and treat invasive plant species on 1.5 acres of adjacent riparian area on the East Branch (RM 12.6). This work will reduce sediment loads, helping to address a downstream siltation impairment (see pp. 46-48 in NPS-IS). This project is located in the City of Kirtland, Lake County, Ohio 2,475 feet south of Kirtland Chardon Road, adjacent to Wisner Road. CRWP will assist with grant administration, project management, and educational deliverables. CRWP conducted a QHEI and BEHI at the project site in

		November 2020. The site received a QHEI score of 69 (narrative of “Good”) and a BEHI score of 33.75 (narrative of “Very High”). This project will build on a recently completed streambank stabilization, funded by local funds and the Ohio EPA Section 319 grant program and closed out in 2020, which stabilized 425 linear feet of the East Branch approximately 2,500 feet upstream of the proposed project.
<i>criteria d</i>	Estimated Total cost	Streambank stabilization \$159,375.00 Floodplain Restoration \$19,221.00 Invasive Treatment \$3,750.00 Site Assessment \$15,000.00 Design Permitting \$85,000.00 Restoration Oversight and Coordination \$15,000.00 Total \$297,346.00
<i>criteria d</i>	Possible Funding Source	Ohio EPA Section 319 Grant
<i>criteria a</i>	Identified Causes and Sources	Causes: direct habitat alterations, flow alteration, thermal modifications, siltation, organic enrichment/DO, and nutrients Sources: dredge mining, land development/suburbanization, flow regulation/modification, urban runoff/storm sewers (NPS), channel erosion/incision from upstream hydromodifications
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	The objectives for Critical Area 1 include: Objective 1: Reforest 34.6 acres of riparian buffer Objective 2: Restore 6,034 linear feet of eroding streambanks through bioengineered streambank stabilization and natural channel design. Objective 3: Restore 20 acres of riparian wetlands near the mouth of the East Branch.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	<ul style="list-style-type: none"> • 1.5 acres of the 34.6 acres of riparian buffer in Objective 1 will be met (4%) • 425 linear feet of the 6,034 linear feet in Objective 2 will be restored (7%) There is a recognition that there is a lag time associated with nonpoint source related projects and measured stream response. With respect to the Goals for Critical Area 1, QHEI will be the main driver as that will dictate the habitability of fish and macroinvertebrates. It is expected that the restoration project will improve QHEI at the project site from 69 to 82 or better with a year of restoration by reducing bank erosion and improving instream vegetative cover. This project will also maintain or improve the QHEI Score at RM 12.15, currently scoring 76.0, with maintenance or incremental increases in the IBI, MIWB, and ICI scores for the next several years thereafter.
	Part 3: Load Reduced?	Nitrogen Reduction: 142.9 lbs/year Phosphorus Reduction: 55 lbs/year Sediment Reduction: 89.3 tons/year
<i>criteria i</i>	How will the effectiveness of this project in addressing the NPS impairment be measured?	The success of the project will be evaluated through the reduction of pollutant loads at the project site, the increase of QHEI score and the decrease in Modified BEHI score. Success will also be measured by maintaining full attainment of the East Branch Chagrin River’s coldwater habitat aquatic life use designation at station 302104, E. Br. Chagrin R. @ Kirtland Rd (RM 12.15).
<i>criteria e</i>	Information and Education	The following Outreach Deliverables are proposed: Project Fact Sheet - 1 Create/Maintain Websites - 1 Project sign -1 Site Tour -1

Nine Element Criteria	Information needed	Explanation
<i>n/a</i>	Title	American-Croatian Lodge Dam Removal and Stream Restoration Project (Phase I)
<i>criteria d</i>	Project Lead Organization & Partners	Munson Township, Geauga County, OH (grant sponsor); American-Croatian Lodge of Chardon, Ohio (private landowner); Brown and Caldwell (landowners' engineering/design consultant); Shumaker Consulting Engineering & Land Surveying (landowners' engineering/design consultant); Chagrin River Watershed Partners (grant management; education and outreach)
<i>criteria c</i>	HUC-12 and Critical Area	East Branch-Chagrin River (041100030401) Critical Area # 2 (Addressing Direct Habitat Alterations)
<i>criteria c</i>	Location of Project	10022 Mulberry Road, Munson Township, Geauga County, Ohio Coordinates: 41.566187, -81.282241 This project will be completed on one parcel owned by the American Croatian Lodge on Mulberry Road in Munson Township. The restored areas will be protected through an environmental covenant to be completed through this project.
<i>n/a</i>	Which strategy is being addressed by this project?	Restore Streams using Natural Channel Design Methods (Goal 2.01 from Ohio EPA's Nonpoint Source Management Plan Update) Restoring Natural Flow (Goal 2.04 from Ohio EPA's Nonpoint Source Management Plan Update)
<i>criteria f</i>	Time Frame	Short-Term (Priority) (1-3 yr)
<i>criteria g</i>	Short Description	This project (Phases I and II) will remove two failing earthen dams and restore 1,190 linear feet of natural stream channel and floodplain along Harris Creek, a direct coldwater habitat tributary to the East Branch of the Chagrin River. Specifically, Phase I will remove the upper earthen dam which has failed, flatten and stabilize slope failures along the dam, and restore 150 linear feet of natural channel and tie into the existing stream.
<i>criteria g</i>	Project Narrative	The American-Croatian Lodge has two existing dams on their property (associated with upper and lower retention ponds/impoundment areas) which have both failed, resulting in overflows and significant flooding events in recent years. The upper dam has experienced complete failure. A large breach exists in the center of the dam at the location of the principal spillway. The breach currently has shear sides that are prone to erosion. This exposed and unstable slope is contributing to the sedimentation of the lower impoundment, which is also filled with invasive vegetation. The outlet structure at the lower impoundment is structurally impaired. There are various existing drainage ditches that follow the access road. They do not appear to provide proper drainage conveyance to the stream that ultimately discharges stormwater from the property. There are also existing drainage pipes that collect stormwater runoff from the road at the front of the property. Parking lot drains exist as well but are completely silted in or are full of leaves and debris. The proposed project will address the above issues through dam removal, slope stabilization, and the establishment of a new restored natural channel. Phase I will include the following components:

		<ul style="list-style-type: none"> Restore 150 linear feet of natural channel and tie into existing stream. Flatten and stabilize slope failures along upper earthen dam which has failed. <p>Phase II will include the following components:</p> <ul style="list-style-type: none"> Restore 560 linear feet of floodplain within lower dam impoundment. Remove lower earthen dam and restore 910 linear feet of natural stream channel. Install a three-sided structure for restored stream channel to flow under existing access road. Existing storm pipe removed; new 24" culvert under walkway and new 230-foot drainage ditch to natural channel. New 48" culvert and 130 linear feet of restored natural channel. <p>The project will be implemented to achieve several important goals: to restore an Ohio coldwater stream and floodplain using natural channel design methodology, reduce nonpoint source pollutants (nutrients and sediment), improve stream and riparian habitat, reverse the impacts of stream hydromodification caused by the construction and operation of dams and impoundments, improve water quality, manage stormwater runoff, remove invasive species, and plant native vegetation.</p> <p>Two Qualitative Habitat Evaluation Index (QHEI) assessments were completed in 2021: one within the Phase I restoration reach (uppermost dam and former basin area) and one within a reference reach (same stream but further upstream). The restoration reach resulted in a QHEI score of 59.75, whereas the reference reach resulted in a score of 79. Implementation of the proposed project is predicted to improve the QHEI score to an "Excellent" narrative rating (≥ 70 for headwater streams) for the restoration reach through improvements in specific categories, such as channel morphology, substrate, and pool/slide/riffle/run quality.</p>
<i>criteria d</i>	Estimated Total cost	<p>Total estimated project cost (Phase 1 only): \$446,600</p> <p>Project design/engineering and permitting: \$72,000 Stream Restoration and Stabilization: \$360,000 Grant management and educational outreach: \$13,600 Educational signage at project site: \$1,000</p> <p><i>Costs may need to be updated at time of grant application.</i></p>
<i>criteria d</i>	Possible Funding Source	Ohio EPA Section 319 Grant Program; Ohio EPA WRRSP; Great Lakes Restoration Initiative; Contributions from Project Partners
<i>criteria a</i>	Identified Causes and Sources	<p><i>Causes:</i> direct habitat alteration, flow alteration, sedimentation, thermal modifications</p> <p><i>Sources:</i> dams/flow modification, removal of riparian vegetation, land development/suburban development</p>
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	<p>The objectives for Critical Area 2 include:</p> <p>Objective 1: Remove 6 fish barriers Objective 2: Restore 1,000 linear feet of in-stream habitat using natural channel design features and principles</p> <p>Harris Creek (tributary to the East Branch of the Chagrin River at RM 14.62) is in partial attainment of its coldwater aquatic life use at RM 0.1 (2004) due to a low IBI fish diversity score (38). This project will help maintain a count of at least 1 coldwater fish species at Harris Creek RM 0.1 (Critical Area 2, Goal 1 – not</p>

		achieved), maintain a count of at least 8 coldwater macroinvertebrate taxa at Harris Creek RM 0.1 (Critical Area 2, Goal 2 – achieved), and maintain a QHEI score of ≥ 62.5 at Harris Creek RM 0.1 (Critical Area 2, Goal 3 – achieved).
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	<p>For Phases I and II of this project:</p> <ul style="list-style-type: none"> • 1 out of 6 fish barriers will be removed, meeting 17% of Objective 1 • 1,190 linear feet of the 1,000 linear feet of Objective 2 will be met (119%) <p>For Phase I of this project only:</p> <ul style="list-style-type: none"> • 150 linear feet of the 1,000 linear feet of Objective 2 will be met (15%) <p>There is a recognition that there is a lag time associated with nonpoint source related projects and measured stream response. With respect to the Goals for Critical Area 2, QHEI will be the main driver as that will dictate the habitability of fish and macroinvertebrates. Implementation of the proposed project is predicted to improve the QHEI score to an “Excellent” narrative rating (≥ 70 for headwater streams) for the restoration reach through improvements in specific categories, such as channel morphology, substrate, and pool/slide/riffle/run quality.</p>
	Part 3: Load Reduced?	<p>Total estimated load reductions for this project (Phases I and II), estimated using the USEPA Region 5 Model:</p> <p>Sediment: 1,428 tons/year Phosphorus: 714 pounds/year Nitrogen: 714 pounds/year</p>
<i>criteria i</i>	How will the effectiveness of this project in addressing the NPS impairment be measured?	If the project is funded through the Ohio EPA 319 program, staff from the OEPA-DSW Ecological Assessment Unit will perform both pre- and post-project monitoring.
<i>criteria e</i>	Information and Education	<p>The American-Croatian Lodge, Munson Township, and Chagrin River Watershed Partners will present public information and hold education activities to inform the public about the project and its environmental benefits. Signs posted at the Mulberry Road property entrance and by the pavilion where the new stream and existing stream will connect will provide passive education on nonpoint source pollution and water quality benefits provided by the project to Lodge members and visitors. Throughout the project design and construction, the Lodge and Township will engage the community and stakeholders. A summary of the project will be included on the Lodge’s website and updates will be posted on social media channels. At the project completion, the Lodge will host two tours of the project to professional, watershed and/or civic groups to explain the design and construction process, discuss nonpoint source pollution and convey the water quality benefits provided by the project.</p> <p>The target audience will be CRWP member communities that have coldwater habitat streams, but the information will be replicable and widely distributed across other coldwater watersheds in the Central Lake Erie Basin.</p>

Nine Element Criteria	Information needed	Explanation
n/a	Title	East Branch Chagrin River Stream Restoration
criteria d	Project Lead Organization & Partners	Chagrin River Watershed Partners, Private Landowner
criteria c	HUC-12 and Critical Area	East Branch Chagrin River (041100030401), Critical Area 1
criteria c	Location of Project	<p>Latitude/Longitude Coordinates: 41.63184, -81.35167</p> <p>This project will be completed on one privately owned parcel off Chillicothe Road in the City of Kirtland, Lake County, Ohio. The restored areas will be protected through an environmental covenant to be completed through this project.</p>
n/a	Which strategy is being addressed by this project?	Stabilize eroding streambanks using bioengineering methods (Goal 2.03.02 from Ohio EPA's Nonpoint Source Management Plan Update)
criteria f	Time Frame	Short-Term (Priority) (1-3 yr)
criteria g	Short Description	This project will stabilize 610 linear feet of streambank and create 0.5 acres of floodplain wetland utilizing bioengineering methods along the East Branch of the Chagrin River in the City of Kirtland, resulting in sediment and nutrient load reductions.
criteria g	Project Narrative	<p>The Chagrin River Watershed Partners (CRWP) will hire a design-build team to restore 610 linear feet of stream riparian corridor using bioengineering methods and create 0.5 acres of riparian wetland floodplain along the East Branch of the Chagrin River. The location of this project is approximately 4.2 miles upstream of the confluence of the East Branch and Main Branch of the Chagrin River. This work will reduce sediment loads, helping to address downstream siltation, as well as improve habitat within the East Branch of the Chagrin River and the downstream portions of the Chagrin River. This project is located in the City of Kirtland, Lake County, Ohio. Conceptual plans propose to restore approximately 610 linear feet of stream bank via bank stabilization, floodplain expansion and revegetation. The floodplain expansion will move the top of bank approximately 48' inland from its current location, creating an estimated 0.5 acres of accessible floodplain. At the toe of the floodplain is proposed rock toe stabilization and a series of bendway weirs. These structures will help protect the bank and focus the energy away from the meander. This floodplain will be further stabilized with bioengineering via planting of native vegetation and the installation of several living/dead dikes.</p> <p>The project will be implemented to achieve several important goals: to stabilize eroding streambanks using bioengineering and natural channel design methods along an Ohio State Scenic River, reduce nonpoint source pollutants (nutrients and sediment), improve stream and riparian habitat, reverse the impacts of stream hydromodification caused by land use development, improve water quality, manage stormwater runoff, and plant native vegetation.</p>
criteria d	Estimated Total cost	<p>Total estimated project cost: \$327,639.29</p> <p>Project design/engineering and permitting: \$30,476.00. Stream Restoration and Stabilization: \$264,508.00 Grant management and educational outreach: \$31,655.29 Educational signage at project site: \$1,000.00</p> <p>Costs may need to be updated at time of grant application.</p>

<i>criteria d</i>	Possible Funding Source	Ohio EPA Section 319 Grant, H2Ohio
<i>criteria a</i>	Identified Causes and Sources	Causes: direct habitat alterations, flow alteration, sedimentation Sources: land development/suburbanization, urban runoff/storm sewers (NPS), channel erosion/incision from upstream hydromodifications, removal of riparian vegetation
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	The objectives for Critical Area 1 include: Objective 1: Reforest 34.6 acres of riparian buffer. Objective 2: Restore 6,034 linear feet of eroding streambanks through bioengineered streambank stabilization and natural channel design. Objective 3: Restore 20 acres of riparian wetland habitat. This project is important for maintaining the Chagrin River’s downstream attainment status. The Chagrin River is currently in full attainment of its warmwater aquatic life use at Chagrin R. At Willoughby @ Ridge Rd. (St. Rt. 84), RM 4.95. This project will help maintain or improve the IBI score of 45.0 (Goal 20), the ICI of 34 or better (Goal 21), the MIWB of 8.73 (Goal 22), and the QHEI score of 81.0 (Goal 23). The Chagrin River is also in full attainment at all other downstream assessment points heading North towards Lake Erie, including the Chagrin R. At Willoughby @ Todd Field Restoration Area (RM 4.20), The Chagrin R. At Willoughby, Dst. Mentor Ave. (U.S. Rt. 20) (RM 3.90), The Chagrin R. @ Park Off Reeves Rd (RM 2.72), And Chagrin R. At Eastlake, 0.5 Mi. Upst. Lake Shore Blvd. (RM 1.50). This project is of critical importance for maintaining the attainment of water quality standards downstream.
	Part 2: How much of the needed improvement for the whole Critical Area is <i>estimated</i> to be accomplished by this project?	<ul style="list-style-type: none"> • 0.5 acres of the 34.6 acres of riparian buffer in Objective 1 will be revegetated (1.4%) • 610 linear feet of the 6,034 linear feet in Objective 2 will be restored (10%) • 0.5 acres of the 20 acres of riparian wetland habitat in Objective 3 will be restored (2.5%) <p>There is a recognition that there is a lag time associated with nonpoint source related projects and measured stream response.</p>
	Part 3: Load Reduced?	Nitrogen Reduction: 54.71 lbs/year Phosphorus Reduction: 27.39 lbs/year Sediment Reduction: 64.98 tons/year
<i>criteria i</i>	How will the effectiveness of this project in addressing the NPS impairment be measured?	The success of the project will be evaluated through the reduction of pollutant loads at the project site and the increase of QHEI score. Success will also be measured by maintaining or improving QHEI, IBI, and ICI scores of the Chagrin River at Willoughby @ Ridge Road. (St. Rt. 84).
<i>criteria e</i>	Information and Education	Chagrin River Watershed Partners will create and present information and educational opportunities to inform the public about the project and its environmental benefits. A summary of the project will be included on Chagrin River Watershed Partners’ website. Educational signage will be installed to provide passive education on nonpoint source pollution and water quality benefits provided by the project to City residents. At project completion, the design/build contractor, or CRWP will present at a CRWP Board of Director’s meeting to explain the design and construction process, discuss nonpoint source pollution, and convey the water quality benefits provided by the project. Additionally, a project summary will be included in CRWP’s Annual Report to

		<p>illustrate the nonpoint source pollution and water quality benefits provided by the project to residents within the Chagrin River Watershed.</p> <p>The following Outreach Deliverables are proposed: Project Fact Sheet - 1 Create/Maintain Websites – 1 Project Presentation – 1 CRWP Annual Report – 1 Educational signage - 1</p>
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Nine Element Criteria	Information needed	Explanation
<i>n/a</i>	Title	<i>Cistern Stormwater Management Project</i>
<i>criteria d</i>	Project Lead Organization & Partners	<i>Lead - Holden Forests& Gardens: Partners – Chagrin River Watershed Partners, Inc.; Lake County Soil and Water Conservation District</i>
<i>criteria c</i>	HUC-12 and Critical Area	<i>East Branch of the Chagrin River (041100030401:), Critical Area 3</i>
<i>criteria c</i>	Location of Project	<i>Holden Arboretum 9480 Sperry Road, Kirtland, Ohio 44094</i>
<i>n/a</i>	Which strategy is being addressed by this project?	<i>Urban Sediment and Nutrient Reduction Strategies: Reduce the rate and amount of runoff. Goals 4.01.01(B) and 4.01.02(B) from Ohio EPA’s Nonpoint Source Management Plan Update</i>
<i>criteria f</i>	Time Frame	<i>Short-Term (Priority) (1-3 yr)</i>
<i>criteria g</i>	Short Description	<i>Holden Forests and Gardens is committed to enhancing nonpoint source pollution treatment at 9480 Sperry Road in Kirtland, Ohio, within the horticulture and facilities service yard at Holden Arboretum. This initiative aims to improve water quality in Pierson’s Creek, a tributary of the East Branch of the Chagrin River, by installing cisterns to capture and reduce runoff from 10,164 square feet of rooftop surface. This project will help maintain the full attainment of Pierson Creek’s CWH/EWH ALUs at river mile 0.4 by addressing sources of impairment related to urban runoff, land development, and flow modifications.</i>
<i>criteria g</i>	Project Narrative	<p><i>HF&G proposes a key stormwater management project focused on water conservation and environmental protection to improve water quality in Pierson’s Creek, a tributary of the East Branch of the Chagrin River. The primary goal is to enhance sustainable water management and mitigate pollution.</i></p> <p><i>The primary objective is to capture and use rainwater by harvesting up to 254,184 gallons annually from roof runoff. To achieve this, we plan to install two 7,800-</i></p>

		<p><i>gallon cisterns, to support irrigation, compost operations, and fire suppression. This stormwater retrofit will capture runoff before it enters a tributary of Pierson's Creek.</i></p> <p><i>The cistern installation is estimated to cost approximately \$35,000. Costs include a required pump and electrical setup as well as plumbing to connect overflow to a stormwater bioretention basin. The overflow systems will direct excess water to the stormwater basin. Harvested rainwater will irrigate trees across 200+ acres, provide water for compost bay operations, and serve as an emergency supply for fire suppression during droughts.</i></p> <p><i>This project can begin upon securing funding. Installation is expected to take 6 to 12 months.</i></p> <p><i>Efforts (outside of 319 funding) will also include the installation a vehicle wash bay system to capture and treat wash water from HF&G's fleet of 50 vehicles, eliminating direct discharge into the stormwater system which drains into the Pierson Creek sub-watershed of the Chagrin.</i></p> <p><i>HF&G has invested significantly in reducing nonpoint source pollution in its service yard. In 2014, they partnered with Chagrin River Watershed Partners, Inc. (CRWP) to voluntarily develop a Good Housekeeping Plan. CRWP's recommendations included covering the fleet of vehicles and equipment, managing 370 cubic yards of annual horticultural waste, and installing a bioretention area to treat runoff from impervious surfaces. Due to space constraints in the existing service yard, HF&G sought technical guidance from Lake County Soil and Water Conservation District to explore relocating operations. This led to a \$600,000+ investment in a new service yard in an adjacent field, including a garage and a large bioretention basin. Additionally, a 2023 Ohio EPA grant enabled the establishment of a compost facility to manage horticultural waste.</i></p> <p><i>Further EPA 319 funding will support additional stormwater best management practices (BMPs) at our service yard which will protect a tributary of the East Branch of the Chagrin River, preserving its dual Coldwater Habitat/Exceptional Warmwater Habitat aquatic life use designation.</i></p>
<i>criteria d</i>	Estimated Total cost	<p><i>Total estimated Project Cost: \$35,000 (319 Grant)</i></p> <p><i>Cistern installation costs include a required pump and electrical setup as well as plumbing to connect overflow to a stormwater bioretention basin.</i></p>
<i>criteria d</i>	Possible Funding Source	<i>Ohio EPA Section 319 Grant</i>
<i>criteria a</i>	Identified Causes and Sources	<i>Pierson Creek is designated dual Coldwater Habitat and Exceptional Warmwater Habitat aquatic life use (ALU) and is in full attainment of both ALUs at river mile 0.4 (2009). Causes of impairment for Pierson Creek include thermal modifications, siltation, organic enrichment, nutrients, flow alteration, and direct habitat alterations. Sources of impairment for Pierson Creek include urban runoff/storm sewers, land development/suburbanization, and flow regulation/modification.</i>
<i>criteria b & h</i>	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	<p><i>With the goals being to achieve and maintain an ICI score of ≥34 and attain a count of at least 1 coldwater fish species at Pierson Creek upstream of Sperry Road (RM 0.4), reasonable objectives are:</i></p> <ul style="list-style-type: none"> <i>Objective 1: Implement green infrastructure projects (such as bioretention basins, rain gardens, permeable pavement, and tree canopy expansion) within Critical Area #3 to retain, detain, and/or treat runoff</i>

		<p>from at least 75 acres (10 million gallons annually) of urbanized impervious surfaces (e.g., roads, parking lots, rooftops).</p> <ul style="list-style-type: none"> • Objective 2: Restore and enhance at least 5,000 linear feet of urban streambanks using bioengineering techniques and riparian reforestation to reduce erosion and improve instream habitat. • Objective 3: Establish at least 10 acres of riparian buffer and wetland retention areas to filter stormwater runoff and improve floodplain connectivity.
	<p>Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?</p>	<ul style="list-style-type: none"> • 0.23 acres of the 75 acres of Objective 1 will be met (0.3%). • 254,184 gallons of the 10 million gallons of Objective 1 will be captured annually (2.5%). <p>The expected measurable improvements for biological and chemical impairments in Pierson's Creek align with US EPA outcome metrics:</p> <p><i>Biological Improvements</i></p> <ul style="list-style-type: none"> • <i>Reduction in Habitat Degradation:</i> By preventing excessive stormwater runoff, the project will reduce streambank erosion and sediment deposition, improving aquatic habitat conditions. • <i>Increased Macroinvertebrate Diversity:</i> Improved water quality and reduced pollutant loads will enhance benthic macroinvertebrate populations, a key bioindicator of stream health. • <i>Mitigation of Thermal Pollution:</i> Capturing 254,184 gallons of roof runoff annually will prevent heated stormwater from entering the stream, stabilizing water temperature fluctuations that can negatively affect aquatic life. <p><i>Chemical Improvements</i></p> <ul style="list-style-type: none"> • <i>Decrease in Nutrient Loading (Nitrogen & Phosphorus):</i> The cistern system will prevent stormwater from mobilizing nutrients into the creek, potentially reducing phosphorus levels by 30-50% and nitrogen levels by 20-40%, based on EPA BMP effectiveness rates. • <i>Reduction in Biochemical Oxygen Demand (BOD):</i> By preventing organic and chemical pollutants from entering the creek, the project will help maintain dissolved oxygen levels necessary for aquatic life.
	<p>Part 3: Load Reduced?</p>	<p>2.0 pounds/year Nitrogen, 0.4 pounds/year Phosphorus, and 0.1 tons/year sediment will be removed as a result of this project.</p>
<p>criteria i</p>	<p>How will the effectiveness of this project in addressing the NPS impairment be measured?</p>	<p>Success will be evaluated based on:</p> <ul style="list-style-type: none"> • Volume of rainwater harvested and utilized for irrigation and compost operations. • Reduction in runoff into Pierson's Creek. • Public engagement analysis (visitor participation in programs, tours, and online engagement). • Data collection on water quality, monitored in collaboration with watershed partners.

		<ul style="list-style-type: none"> • <i>Number of inquiries made about the project by the target population;</i> • <i>Feedback from collaborators about attainment of project goals and objectives; and</i> • <i>Maintaining full attainment of CWH and EWH ALU designations at Pierson Creek RM 0.4. This sampling will be conducted by Ohio EPA.</i>
<i>criteria e</i>	Information and Education	<p><i>As the Ohio EPA is a trusted leader and environmental steward using innovation, quality service and public involvement to ensure a safe and healthy environment for all Ohioans, it is the intent of HF&G to educate members, guests, and students throughout the Northeast Ohio region about the benefits of reducing runoff, erosion, and sedimentation into the Chagrin River.</i></p> <ul style="list-style-type: none"> • <i>CRWP will work with HF&G to develop a project fact sheet of the completed project. CRWP will present on the project at a Board of Directors meeting (averaging 40 local officials and professional advisors per meeting) and will highlight the project in CRWP’s annual report and on their website and Facebook page. The target audience will be residents of Kirtland in coordination with the City of Kirtland, but the information will be replicable and widely distributed across other cold-water habitat CRWP member communities and other cold-water watersheds in the Central Lake Erie Basin.</i> • <i>HF&G will highlight this project and the support Ohio EPA in a main article in our quarterly magazine, Forests and Gardens. The Forests and Gardens Magazine is distributed to over 22,000 -members including member households, libraries, media outlets and public gardens in Northeast Ohio and beyond.</i>

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Appendix

Appendix A: Acronyms and Abbreviations

A

ALU Aquatic Life Use

B

BEHI Bank Erosion Hazard Index

C

CRWP Chagrin River Watershed Partners, Inc.

CWH Coldwater Habitat

C-CAP Coastal Change Analysis Program

CRWP Chagrin River Watershed Partners, Inc.

E

EB East Branch

EOLP Erie-Ontario Lake Plains

EPA Environmental Protection Agency

EPT Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)

EWH Exceptional Warmwater Habitat

G

GPD Geauga Park District

GPM Gallons Per Minute

H

HSTS Home Sewage Treatment Systems

HUC Hydrologic Unit Codes

I

IBI Index of Biotic Integrity

ICI Invertebrate Community Index

M

MIwb Modified Index of Well-being

N

NLCD National Land Cover Data

NWI National Wetlands Inventory

NPS Non Point Source

NPS-IS Nonpoint Source Implementation Strategic Plan

O

ODNR Ohio Department of Natural Resources
OHIO EPA Ohio Environmental Protection Agency
OSW Outstanding State Waters

P

PCA Priority Conservation Area
PDA Priority Development Area

Q

QHEI Qualitative Habitat Evaluation Index

R

RM River Mile

S

SWCD Soil and Water Conservation District

T

TMDL Total Maximum Daily Load
TSD Technical Support Document

U

USDA United States Department of Agriculture
USGS United States Geological Survey
UT Unnamed Tributary

W

WAP Watershed Action Plan
WRLC Western Reserve Land Conservancy