December 2023
Version 1.1
Approved:
December 5, 2023

BRANDYWINE CREEK

04110002 04 04 Brandywine Creek (HUC 12)

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

Developed by:

Tinker's Creek Watershed Partners
P.O. Box 444
Twinsburg, OH 44087

Tinker's Creek Watershed Partners
Rediscover • Respect • Revitalize

This page intentionally left blank

Acknowledgements

Tinker's Creek Watershed Partners (TCWP) would like to thank the Central Lake Erie Basin (CLEB) Collaborative, West Creek Conservancy and Chagrin Valley Engineering Ltd. for helping coordinate the stakeholder meetings, reviewing the plan, and for providing mapping assistance.

Some introductory portions of the plan were adapted from the *Balanced Growth Plan* (March 2014). The *Nine-Element Nonpoint Source Implementation Strategic Plan (NPS-IS Plan) Tinker's Creek Headwaters* also served as a template for this plan.

The following Tinker's Creek Watershed Partners team and staff are acknowledged for their contribution to this report: Dr. Erica Matheny, Alyssa Mills, Kate Chapel, Harry Stark.

The Northeast Ohio Regional Sewer District (NEORSD) for sharing their biological data and potential stormwater projects with the development team.

The following communities for providing feedback, identifying projects, and providing financial support: Boston Heights Village, The City of Hudson, The City of Macedonia, and The Village of Northfield.

This publication was financed by Boston Heights Village, Hudson, Macedonia, and Northfield Village.

This project was funded in part or totally through the Northeast Ohio Regional Sewer District (NEORSD) Community Cost-Share Program in coordination with City, under the provisions of the NEORSD Regional Stormwater Management Program. The contents and views, including any opinions, findings, or conclusions or recommendations, contained in this publication are those of the authors and have not been subject to NEORSD review and may not necessarily reflect the views of NEORSD, and no official endorsement should be inferred.

Table of Contents

List of Tables

List of Figures

Chapter1: Introduction

This document addresses the **Brandywine Creek HUC-12 (04110002 04 04)**. Brandywine Creek drains 27 square miles in the Summit County communities of Hudson, Macedonia, Boston Heights Village, Northfield Village, Boston Township, Northfield Center Township, Sagamore Hills Township, and Twinsburg Township, and a small portion of Oakwood Village in Cuyahoga County. The main stem of Brandywine Creek is approximately 11 miles long from its headwaters in Hudson to where it joins the Cuyahoga River in the Cuyahoga Valley National Park.

The most well-known geologic formation in the watershed is Brandywine Falls. The 65-foot waterfall drops over bedrock comprised of erosion resistant Berea Sandstone, which settled upon a deep deposit of red Bedford Shale close to 360 million years ago.

In addition to the main branch of Brandywine Creek, a portion of this HUC-12 has another named stream, Indian Creek, which flows south from Oakwood through Macedonia to meet Brandywine Creek at the municipal line between Macedonia and Northfield Center Township.

As State and Federal nonpoint source funding now relies upon the development of NPS-IS plans, this NPS-IS plan is accepted by both the USEPA and Ohio EPA as meeting the 9-minimum element requirements as outlined in the USEPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters*. Tinker's Creek Watershed Partners and its collaborators, including watershed members and communities, local agencies, and other conservation organizations recognize the importance of strategic implementation as we seek to address the impairments within the Brandywine Creek watershed.

1.1 Background

This NPS-IS is an update to the state endorsed *Balanced Growth Plan* which incorporates the whole HUC-12. This document has provided a starting point for initial project implementation to improve and protect the waters of Brandywine Creek with an emphasis on critical areas within the HUC-12.

1.2 Watershed Profile & History

Brandywine Creek headwaters begins in Hudson and meanders west to its confluence with the Cuyahoga River in the Cuyahoga Valley National Park in Sagamore Hills. As it flows west, the main stem of Brandywine Creek is fed by several tributary streams. One main tributary, Indian Creek, begins in Oakwood and flows through Macedonia heading south to its confluence with the main stem at the municipal boundary between the City of Macedonia and Northfield Center Township. The confluence with the Cuyahoga River is within the Cuyahoga Valley National Park.

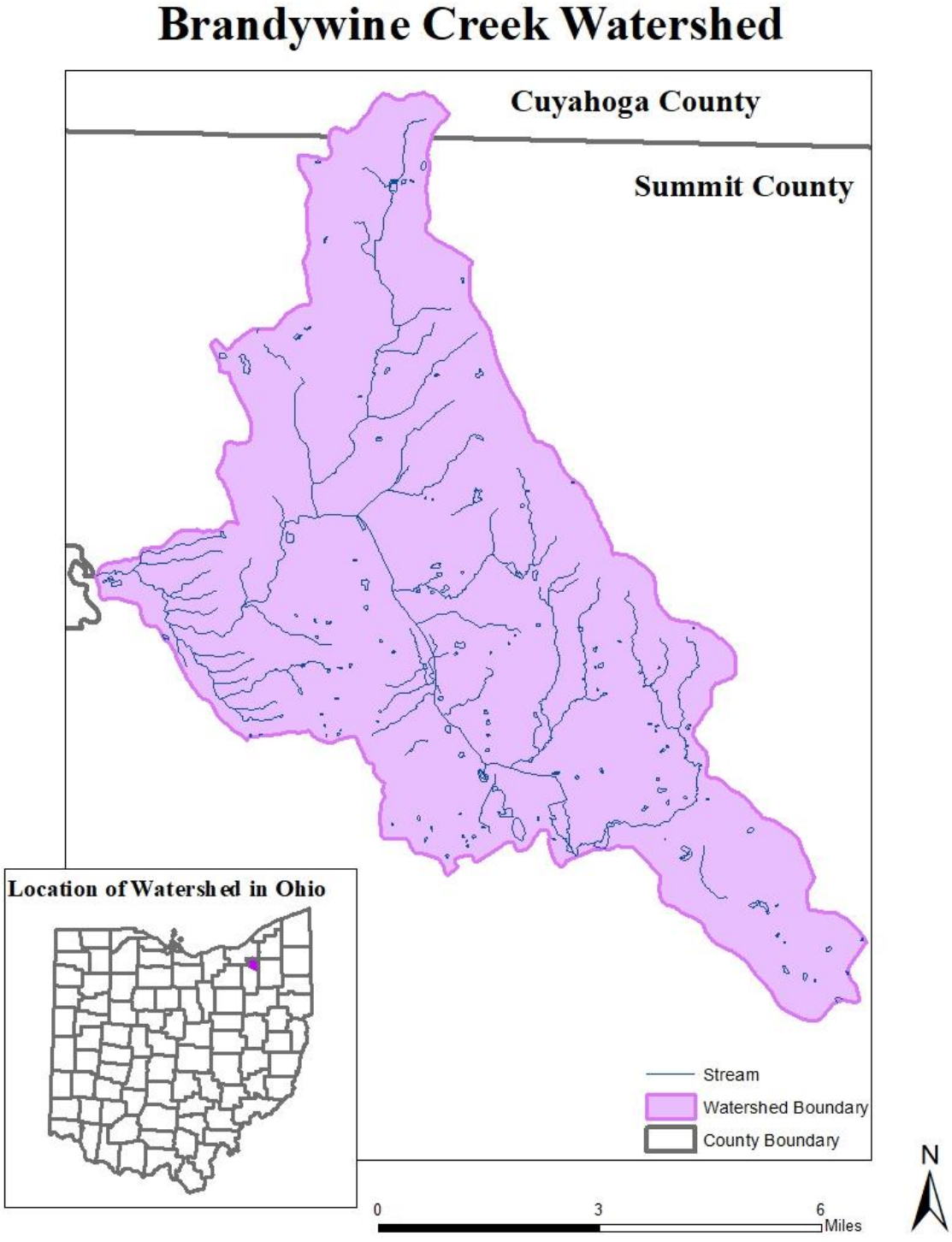

Figure 1: Brandywine Creek Watershed Location Map

Brandywine Creek Watershed HUC-12

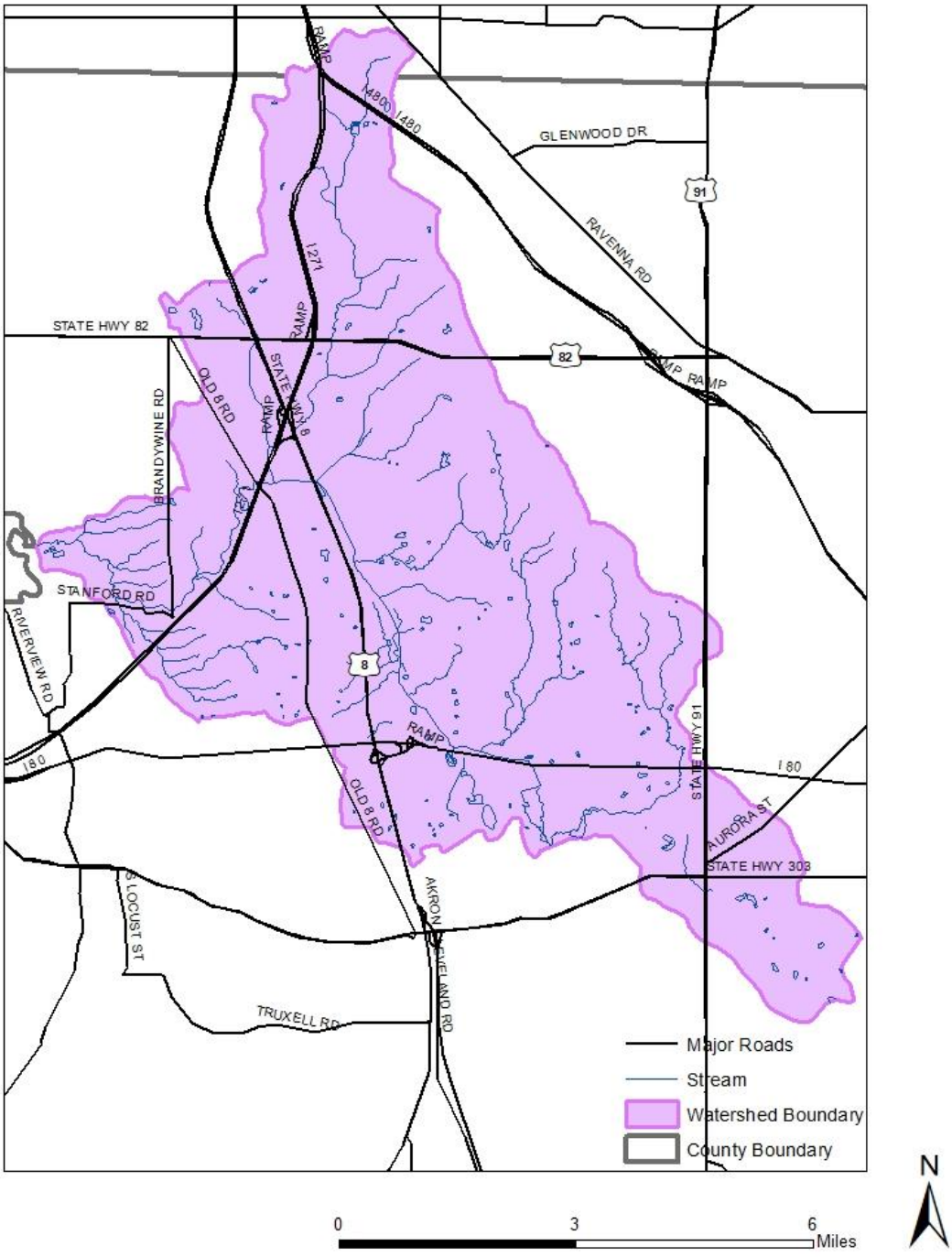

Figure 2: Brandywine Creek HUC-12 Watershed Location Map

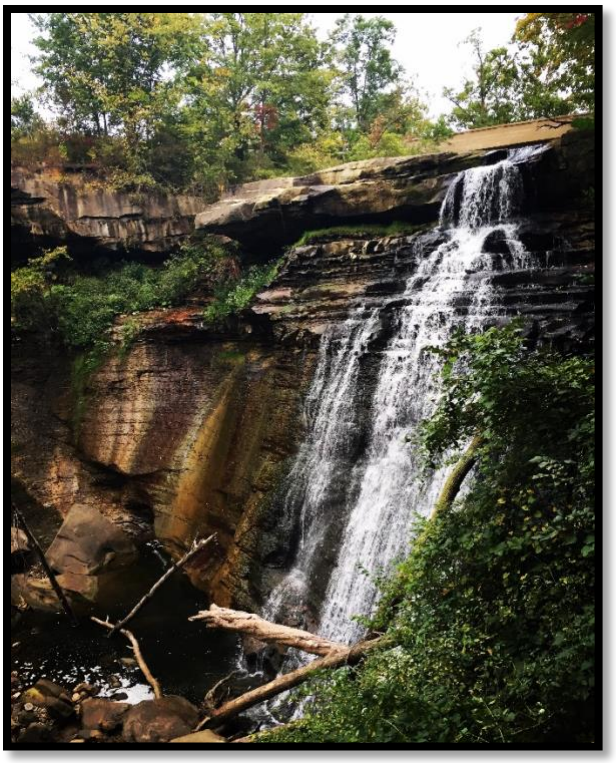

Figure 3: Photograph of Brandywine Creek Falls

At sixty feet, Brandywine Falls stands taller than any other waterfall in the national park. In 1814, entrepreneur George Wallace built a sawmill to take advantage of the energy created by the waterfall. Over the next ten years, Brandywine Village developed around the sawmill. In 1825, George Wallace transferred his mill and properties to his children, who then established the Wallace Brothers Company. The introduction of the Ohio & Erie Canal in the mid-nineteenth century brought new business and settlers to the Cuyahoga Valley who populated new communities in Boston and Peninsula. Without direct access to the canal, however, Brandywine Village watched as goods traveled between Akron and Cleveland, bypassing their own industrial settlement. During the 1920s, Brandywine Village found new life and industry when Willis Hale built the Champion Electric Company amongst the ruins of Wallace's gristmill. Hale's company manufactured restaurant appliances until 1937 when lightening destroyed the factory and ended his business in the valley.

In 1987, the Great Lakes Water Quality Agreement formed to reverse the devastation from industrial pollution, dedicating 43 Areas of Concern (AoC) across the Great Lakes. In 1988, the Cuyahoga Remedial Action Plan Coordinating Committee determined the boundaries of the Cuyahoga AoC, which included the Brandywine Creek watershed. The Great Lakes Water Quality Agreement calls for Remedial Action Plans (RAPs) to restore and protect 10 beneficial uses in the Cuyahoga AoC. An impaired beneficial use means a change in the chemical, physical, or biological integrity of the Great Lakes system of which the Cuyahoga River flows into. Therefore, the Brandywine Creek watershed is an integral part of the process to "delist" the Cuyahoga River as an AoC.

All nine communities within the Brandywine Creek watershed are considered Phase 2 communities. This requires those communities to submit and perform requirements for stormwater management under the National Pollution Discharge Elimination System program (NPDES) program. Tinker's Creek Watershed Partners is working with many of those communities to assist them with Public Involvement Public Education (PIPE) to help satisfy those requirements set forth in the permit.

1.3 Public Participation and Involvement

In 2007, communities in the Brandywine Creek Watershed Planning Partnership (BCWPP) began working together on shared issues of stormwater management and watershed stewardship to create a watershed management plan. In 2013, the State of Ohio endorsed the Brandywine Creek Balanced Growth Initiative Watershed Plan.

The original balanced growth plan (BGP) was published online in March 2014. Extensive input from community representatives, consultants, and agencies was utilized to identify priority conservation and priority development areas in the watershed. The BGP has been the communities' guiding document to implement planned projects and to help strategically place new projects.

In 2014, the BCWPP began communication with Tinker's Creek Watershed Partners (TCWP) to collaborate and establish a partnership. These discussions centered on how TCWP could assist in the implementation of the Brandywine BGP. Representatives from the municipalities of Boston Heights, Macedonia, and Hudson joined these discussions along with Summit Soil & Water Conservation District, Summit Metroparks, and Western Reserve Land Conservancy.

In 2017, TCWP reinvigorated the discussions with the BCWPP with a specific goal in mind. The Ohio and U.S. EPA now requires a 9-Element Nonpoint Source Implementation Strategic Plan (NPS-IS Plan). This is a guiding document that will allow local entities to effectively propose and implement projects.

In order to ascertain the key challenges going forward and update the BGP to a 9-Element Plan, TCWP utilized discussions with some core BCWPP representatives, the Northeast Ohio Regional Sewer District Staff, and West Creek Conservancy.

TCWP held an annual Mayors' Breakfast in March of 2018 where we solicited additional input from the attendees on issues in their communities. In attendance included mayors, city managers, stormwater representatives, and engineers from the watershed communities. Information on critical areas, issues in the watershed, and potential projects were confirmed and/or provided at this meeting.

Input from various watershed partners has helped us to establish critical areas and projects that will help bring these areas into attainment. As the 9-Element Plan is intended to be a working document, we will continue to work with our partners in the watershed to update the document and add additional projects that will help us reach our attainment goals and objectives.

Chapter 2: Watershed Characterization and Assessment Summary

2.1 Watershed Characterization

2.1.1 Physical and Natural Features

Brandywine Creek is a tributary to the Cuyahoga River with a watershed drainage area of 27 square miles. The main stem of Brandywine Creek is approximately 11-miles long and the watershed traverses across Summit County and a small portion of Cuyahoga County. Elevations in the watershed vary, with the highest elevation point being 1,072 feet above mean sea level and the lowest point lying at 662 feet above mean sea levels where Brandywine Creek flows into the Cuyahoga River.

The physiographic features of the watershed are those characteristics related to both the topography and geology of the basin. Brandywine Creek is located within the Glaciated Appalachian Plateau physiographic region, which consists predominately of silty loam and clayey loam soils. Portions of the stream are on bedrock, which forms waterfalls that act as a natural barrier to the passage of fish. Brandywine Falls is the tallest waterfall in the Cuyahoga Valley National Park. Carved by glaciers and ancient streams, this region is less hilly and lacks the rugged quality of the unglaciated landscape.

Slopes vary greatly within the Brandywine Creek watershed, ranging from steep gorge areas where the creek has cut its way down through bedrock to gentle slopes, flat areas, marshes, and wetlands. The pattern of slopes within the watershed is gentle, with the steepest gradients found along the stream banks and where Brandywine Creek flows into the Cuyahoga River. Steep slopes generally have the highest erosion potential from runoff or from channel undercutting of the stream banks. Identifying the steepest slope areas that either would contribute to higher erosion potential or offer the most value for sensitive and unique habitats is a focus.

Other physical characteristics notable within the Brandywine Creek watershed are Class 1, 2 & 3 impoundments and dams, most of which are privately maintained, two (2) of which are owned and maintained by the City of Hudson. Most of these dams have a fail incident recorded in the flood of 2003.

Table 1: Brandywine Creek Dams

Name	Permit #	Class	Owner/ Type	Owner	Location	Receiving Stream	Date Built	Purpose	Impoundment Type	Dam Type
Unknown	Exempt	Exempt			Macedonia	Indian Creek	Unknown		Dam and Spillway	
Unknown	Exempt	Exempt			Northfield Center	Tributary to Brandywine Creek	Unknown		Dam and Spillway	
Unknown	Exempt	Exempt			Boston Heights	Tributary to Brandywine Creek	Unknown		Dam and Spillway	
Lake Forest Estates Dam (formerly Camp Forest		III	Private	PFR Land Company	Macedonia	Tributary to Brandywine Creek	Unknown	Recreation, private	Dam and Spillway	Earthfill

Estates Dam)										
Villa Lago Dam		III	Private	Villa Lago Homeowners Association	Macedonia	Tributary to Brandywine Creek	Unknown	Recreation, private	Dam and Spillway	Earthfill
Lake Forest Dam	N/A	II	Private	Lake Forest Country Club	Hudson	Brandywine Creek	1952	Recreation, private	Dam and Spillway	Earthfill
Pine Lake Dam	N/A	I	Private	Robert Van de Motter	Hudson	Brandywine Creek	1929	Recreation, private	Dam and Spillway	Earthfill
City of Hudson Upper Lake Dam	N/A	II	Public/local	City of Hudson	Hudson	Tributary to Brandywine Creek	Unknown	Flood control, local	Dam and Spillway	Earthfill
City of Hudson Lower Lake Dam	N/A	II	Public/local	City of Hudson	Hudson	Tributary to Brandywine Creek	Unknown	Flood control, local	Dam and Spillway	Earthfill

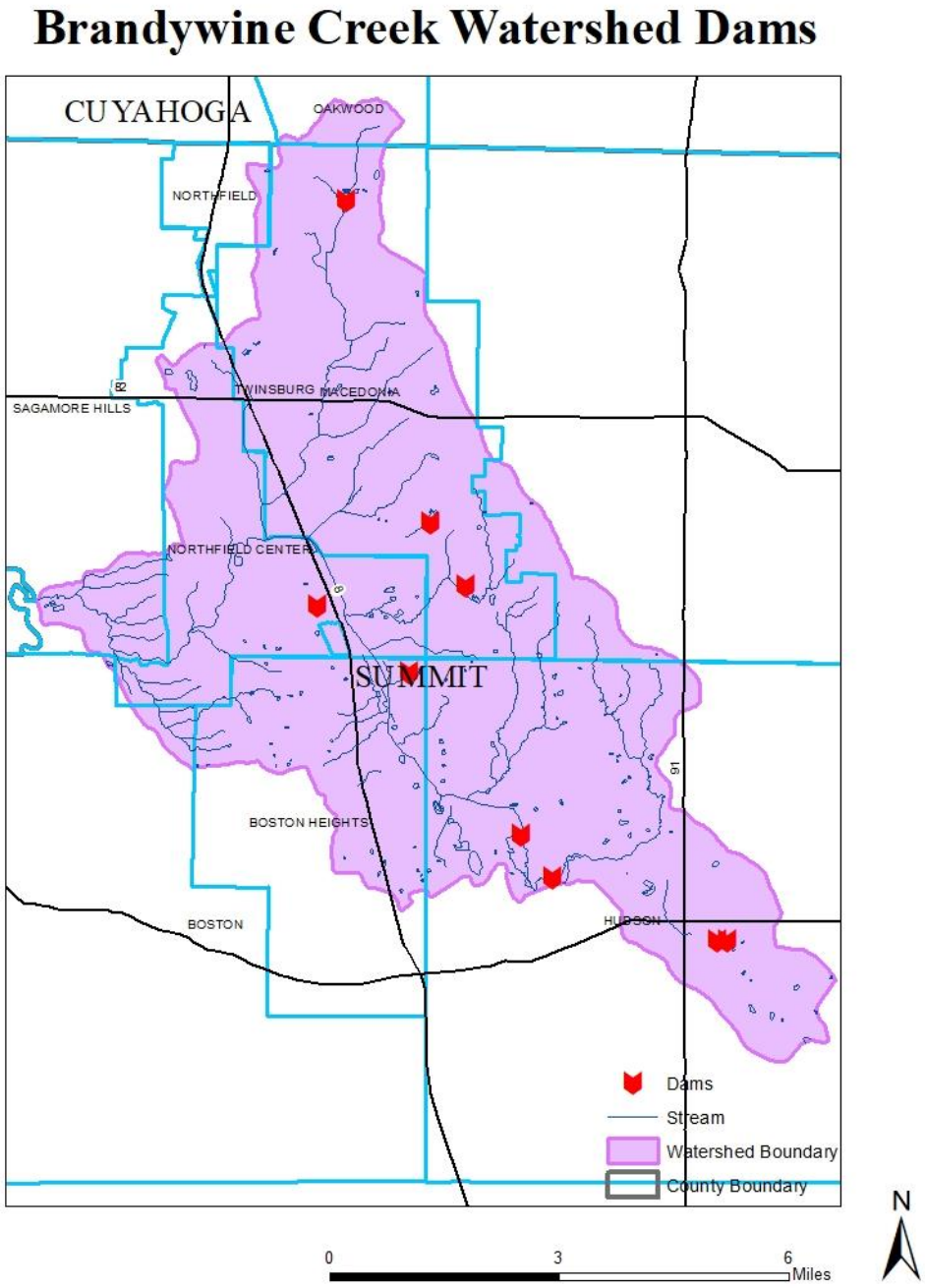

Figure 4: Brandywine Creek HUC-12 Dams/Impoundments Map

Soils are 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 are in their natural condition and are in Group D are assigned to dual classes. The predominant soil series in the Brandywine Creek HUC-12 is as follows:

Ellsworth series – deep soils that are moderately well drained and slowly or very slowly permeable; slopes 2 to 70%.

Mahoning series – deep soils that are somewhat poorly drained and slowly or very slowly permeable; slope ranges from 0 to 6%.

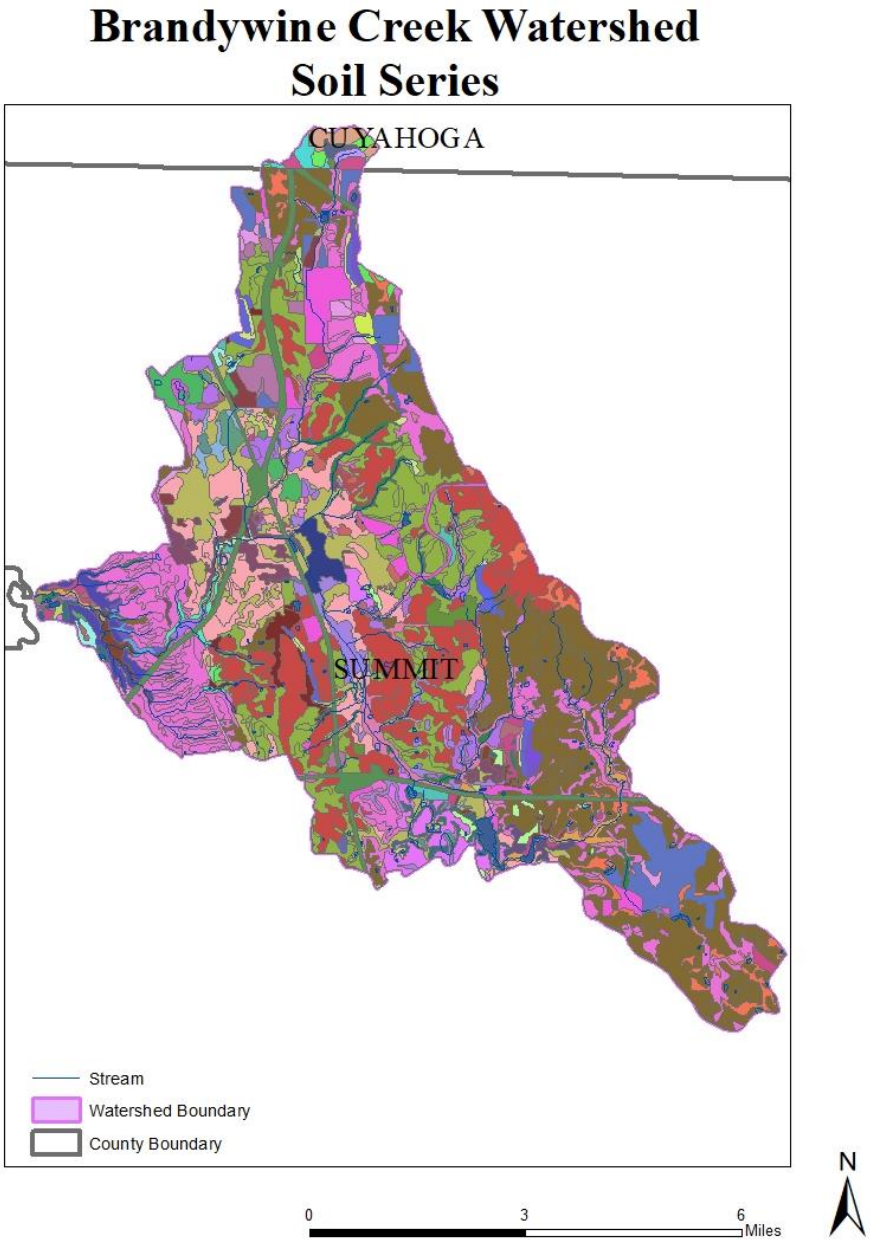

Figure 5: Brandywine Creek HUC-12 Underlying Soil Series Map

The Brandywine Creek watershed contains approximately 299 wetlands (spanning 1,032 acres) with type and quality varying across the watershed. The more urbanized locations in Brandywine Creek contain lower quality wetlands than areas that are currently developing or have not been developed yet, so it is vital to protect these remaining wetlands in the watershed through proper management of resources.

The U.S. Fish and Wildlife Service is the principal federal agency tasked with providing information to the public on the status and trends of wetlands within the United States. This data is shared via the National Wetlands Inventory (NWI). The following Figure indicate wetlands areas within the Brandywine Creek HUC-12 sub-watershed as identified by the NWI.

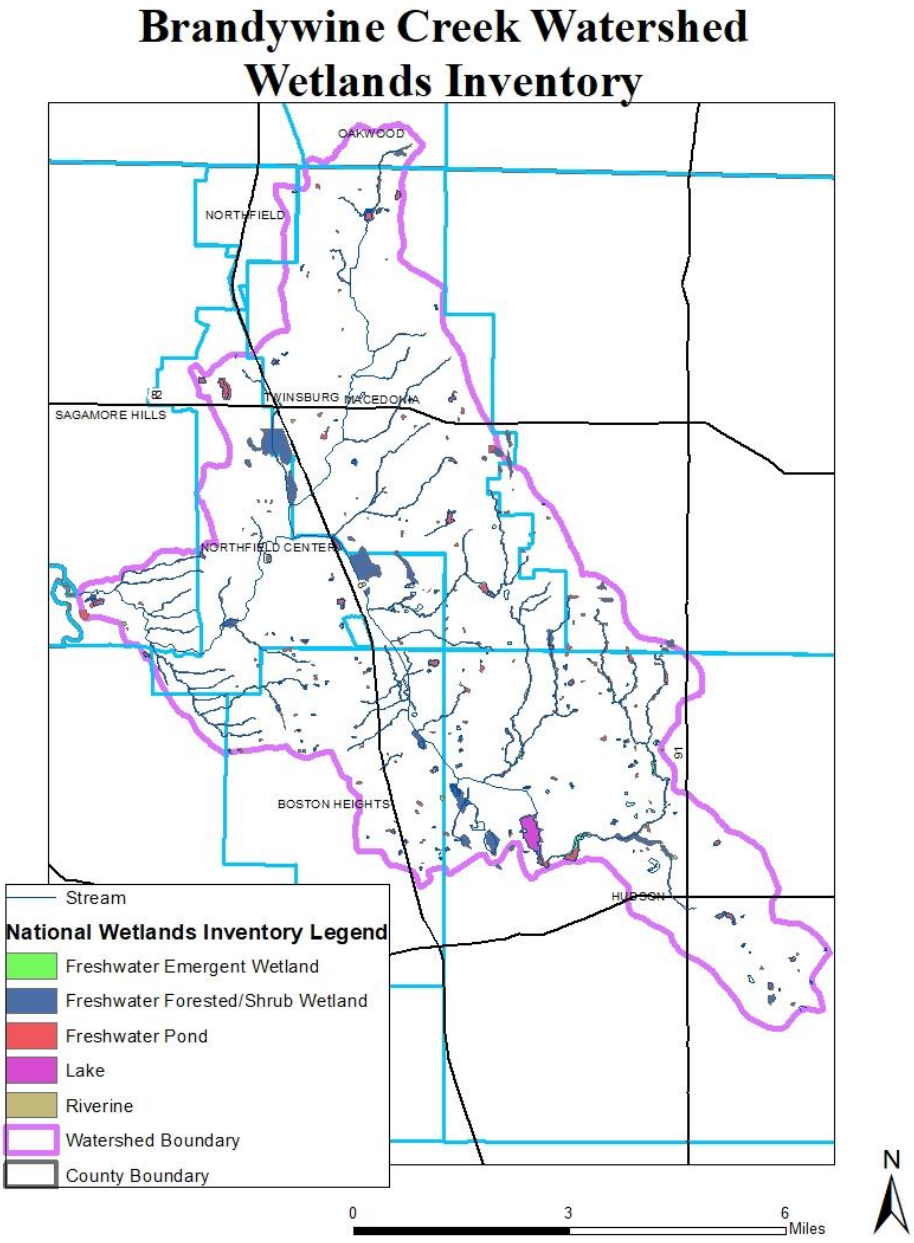

Figure 6: Brandywine Creek HUC-12 National Wetland Inventory Map

The Ohio Department of Natural Resources (ODNR), Division of Wildlife (DOW) maintains the Natural Heritage Database. A review of this database indicates there are six (6) plants listed within the Brandywine Creek watershed (see Table 2).

Table 2: State Listed Plant Species in Brandywine Creek watershed

Scientific Name	Common Name	State Status
Carex straminea	Straw Sedge	Potentially threatened
Corallorhiza maculata	Spotted Coral-root	Potentially threatened
Gentianopsis crinita	Fringed Gentian	Potentially threatened
Spiranthes magnicamporum	Great Plains Ladies'-tresses	Potentially threatened
Corallorhiza trifida	Early Coral-root	Endangered
Zizania aquatic	Southern Wild Rice	Endangered

The U.S. Fish and Wildlife Service (USFWS) maintains a database of federally listed species that can occur within Ohio by County. For the two (2) counties that Brandywine Creek watershed is present in, the USFWS indicates as follows: federally endangered – Piping Plover (*Charadrius melodus*), Indiana Bat (*Myotis sodalis*); federally threatened - Northern Monkshood (*Acotinum noveboracense*), Red knot (*Calidris canutus rufa*), and Northern Long-eared Bat (*Myotis septentrionalis*)

Although the Bald Eagle (*Haliaeetus leucocephalus*) has been de-listed as an endangered species, it is still protected under the Migratory Bird Act, the Bald and Golden Eagle Act, as well as the Lacey Act. USFWS includes the Bald Eagle for all counties in Ohio as a Species of Concern.

Inventories of invasive species have not been conducted for the Brandywine Creek watershed in its entirety. The Ohio EPA has identified the two most common invasive fish species in collections from 2000-2008 as gizzard shad and carp. To date, there have been no reports of any of the Eurasian goby species in the watershed. Other potentially harmful invasive aquatic animal species include zebra mussels, not yet noted in the watershed, and the rusty crayfish (*Orconectes rusticus*), most likely in the watershed. Negative impacts on the watershed associated with the rusty crayfish are not known at this time.

In addition, a number of plant species have invaded the aquatic/semi aquatic habitat which may have negative impacts on the watershed and its associated wetlands. In general, invasive plant species out-compete native plants, resulting in decreased plant diversity, as well as choking off habitat niches, along with chemical impacts associated with decaying biomass. Plant species which fit this classification include reed canary grass (*Phalaris arundinacea*), narrow-leaved cattail (*Typha angustifolia*), buckthorn (*Frangula alnus*), common reed (*Phragmites australis*), garlic mustard (*Alliaria petiolata*), Japanese honeysuckle (*Lonicera japonica*), Japanese knotweed (*Polygonum cuspidatum*), purple loosestrife (*Lythrum salicaria*), and multiflora rose (*Rosa multiflora*). While present in the watershed, large scale impacts attributable to these species have not yet been investigated.

2.1.2 Land Use and Protection

Brandywine Creek HUC-12 (04110002 04 04) has a watershed drainage area of 27 square miles and drains areas within the following communities found within Summit County: Boston Heights Village, Boston Township,

Hudson, Macedonia, Northfield Center Township, Northfield Village, Sagamore Hills Township, and Twinsburg Township; and within Cuyahoga County: Oakwood Village.

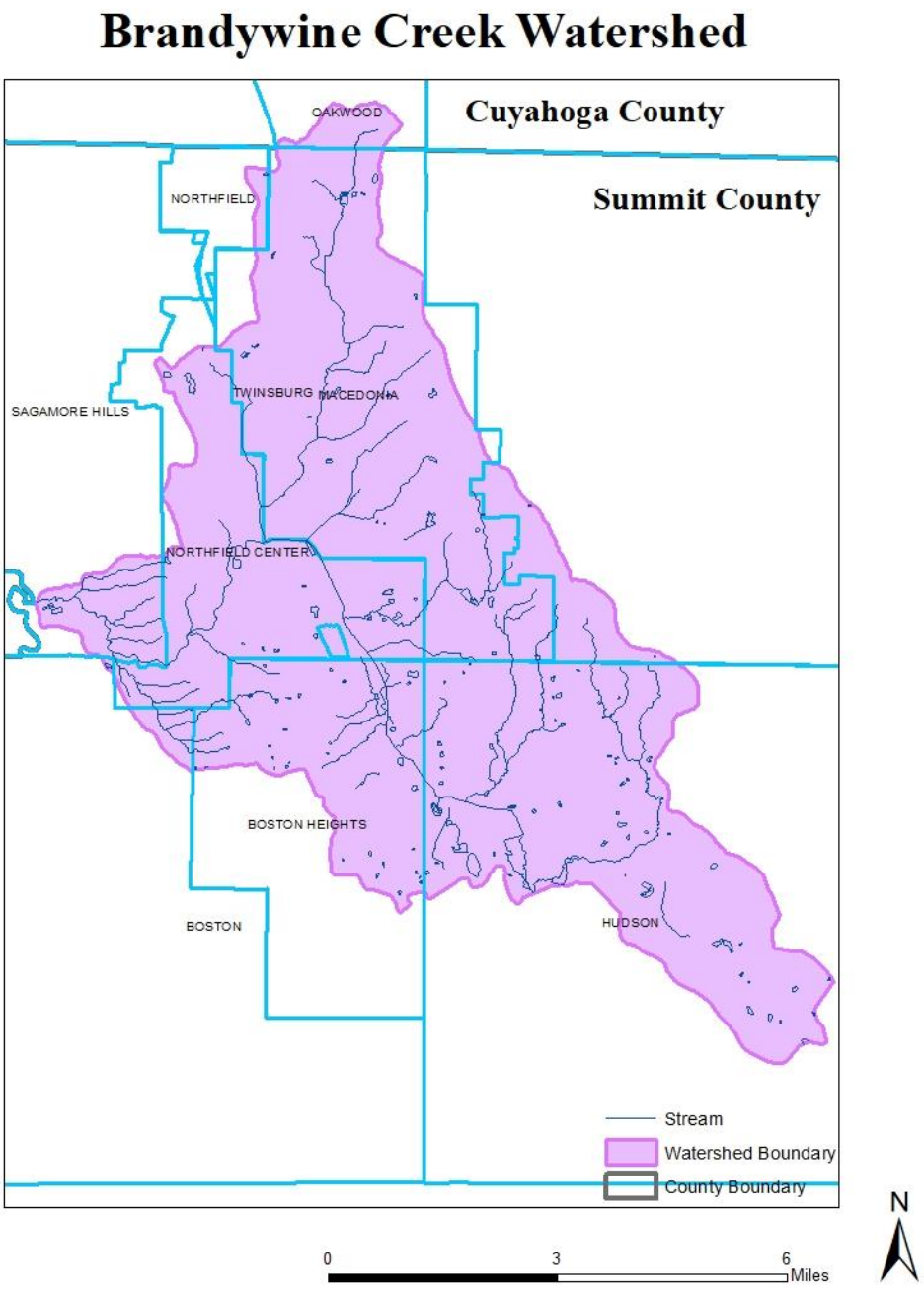

Figure 7: Brandywine Creek HUC-12 Community Map

The late 1990s and 2000s saw significant residential development within the outlying suburbs of both Cleveland and Akron. This HUC-12 still maintains a semi-rural environment. The Brandywine Creek watershed is fortunate in that it has protected lands at the federal, county, and local levels. Land use within this HUC-12 is characterized as the following: 65.40% developed, 27.30% forest, 4.90% grass/pasture, 0.30% row crop and 2.10% other (water) (Ohio Environmental Protection Agency Integrated Report, 2016).

Brandywine Creek Watershed
Land Use/Land Cover

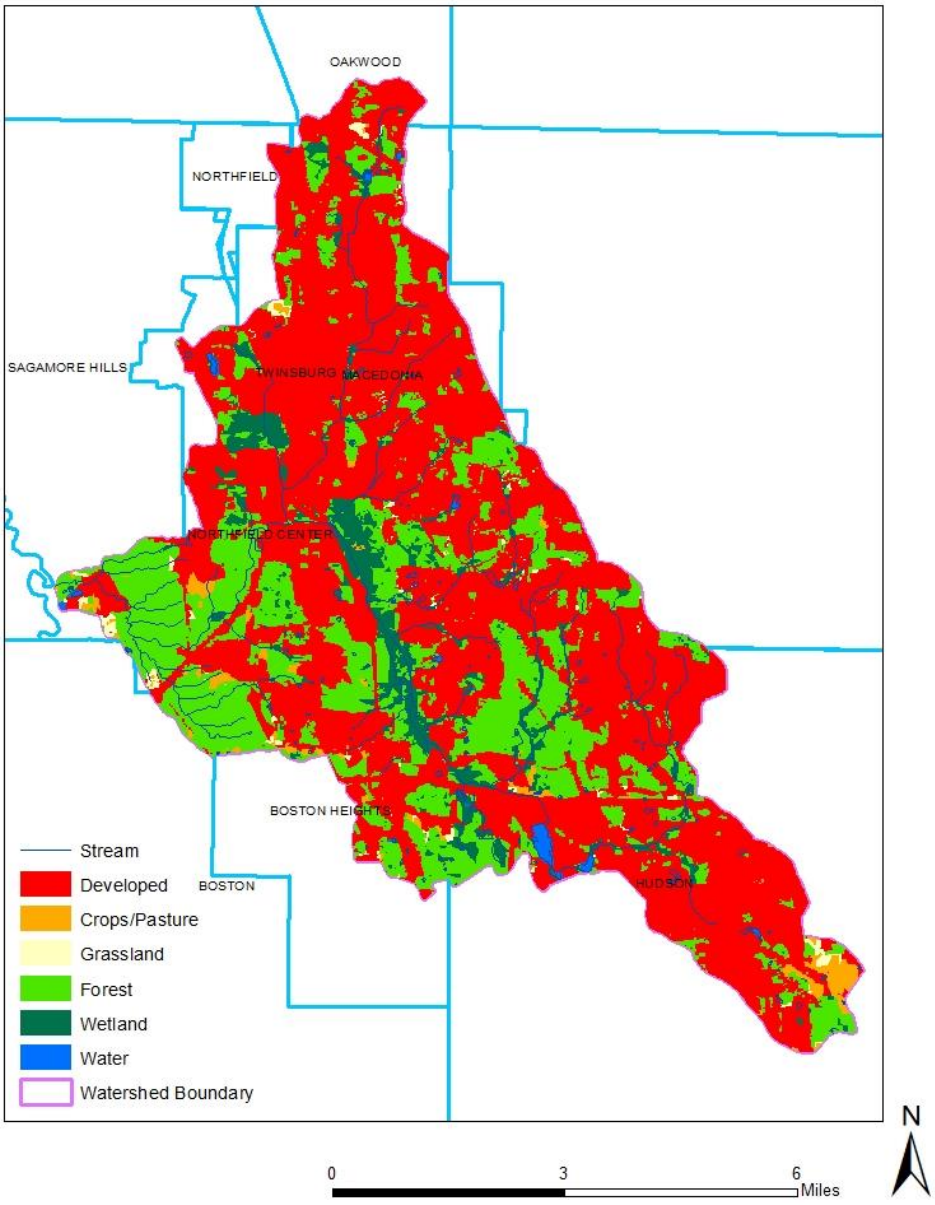

Figure 8: Brandywine Creek HUC-12 Land Use Map

Figure 9: Brandywine Creek looking downstream just above Route 91/downtown Hudson, Summit County, some erosion present.

Figure 10: Viewing the inlet from the outlet of Lower Dam, Hudson, Summit County, these dams potentially effect water quality downstream.

2.2 Summary of Biological Trends

The Ohio EPA completed a TMDL for the Lower Cuyahoga River basin and it was approved by the US EPA in September 2003. Within the Brandywine Creek Watershed portion of the TMDL, several water quality issues were identified. Unknown toxicity, nutrients, organic enrichment/DO, flow alteration, direct habitat alternations, and total dissolved solids were considered the main water quality issues facing Brandywine Creek. Please see Figure 12: Brandywine Creek Watershed Qualitative Habitat Evaluation Index Scores, Figure 13: Brandywine Creek Watershed Invertebrate Index Scores and Figure 14: Brandywine Creek Watershed Index of Biological Integrity Scores.

The OEPA Integrated Report describes Brandywine Creek ask follows:
The upper watershed has seen significant suburban development in the Hudson area and several new, highly eutrophic lakes have been constructed in the headwaters. Poor quality biological communities and enriched conditions were observed at Prospect Rd. (RM 10.0), downstream from Hudson and upstream from the former Hudson #5 WWTP. However, no obvious water quality problems were detected in water chemistry samples. Communities improved but remained impaired (Partial attainment) at Hines Hill Road (RM 7.1) and reached Full attainment (good quality) near the mouth. Conditions near the mouth were much improved compared to 1996 collections and Full attainment documented in 2000 was the first recorded by Ohio EPA in Brandywine Creek since sampling began in 1984. Natural barriers to fish migration (waterfall) may inhibit recolonization of the stream above the waterfall.

The OEPA Integrated Report describes Indian Creek as follows:
Indian Creek is a small Brandywine Creek tributary that receives urban/suburban drainage from the Macedonia area. Fish communities were marginally good but macroinvertebrate communities were fair, resulting in Partial attainment. Numerous tolerant snails (*Physella*) and oligochaetes at RM 1.0 suggest an organic enrichment/DO problem but no obvious indications of sewage were observed on-site or in chemical sampling. Stream habitat in the lower mile was fair (Avg QHEI = 49) but this section of the stream is historically channelized. and listed under maintenance.
Based on attainment of the fish, lack of channel maintenance in the remainder of the basin, and adequate gradient (Avg.15.3 ft/mi.), the WWH use is recommended.

High conductivity levels encountered in 1996 near the mouth were not detected in 2000. The 1996 levels were traced as far upstream as Hudson. A specific source was not found but is believed to have originated from the Hudson WWTP. The Hudson plant was converted into a pump station in 1996 that directed waste to the NEORSD Southerly WWTP. The Ohio EPA collected intensive biological community, chemical water quality, and physical habitat data in the assessment unit from 1999-2000. Brandywine Creek is designated as WWH use while Indian Creek has been recommended as WWH use. Scores and attainment uses from the Ohio EPA's 2016 Integrated Water Quality Monitoring and Assessment Report can be found in the table below (Table 3).

Table 3: Brandywine Creek HUC-12, OEPA Aquatic Life Use Monitoring Sites

Sample Station Name	River Mile	ALU Type	Sampling Year	IBI Score	QHEI Score
Brandywine Creek at Prospect Road	10.0	Non WWH	2000	24	61.5
Brandywine Creek at Hines Hill Road	7.1	Partial WWH	2000	28	55.5
Brandywine Creek at Dst. Waterpark nr. Mouth	0.0	Full WWH	2000	42	57.5
Indian Creek at Blue Jay Trail	1.0	Partial WWH	2000	36	51.5
Indian Creek at Highland Road	0.5	Full WWH	2000	36	46.5

Figure 11: Brandywine Creek; In-stream habitat example with culverted stream section; Ravenna St., Hudson, OH

Figure 12: Portion of Indian Creek, example of stream morphology showing loss of sinuosity and riparian area maintenance/mowing

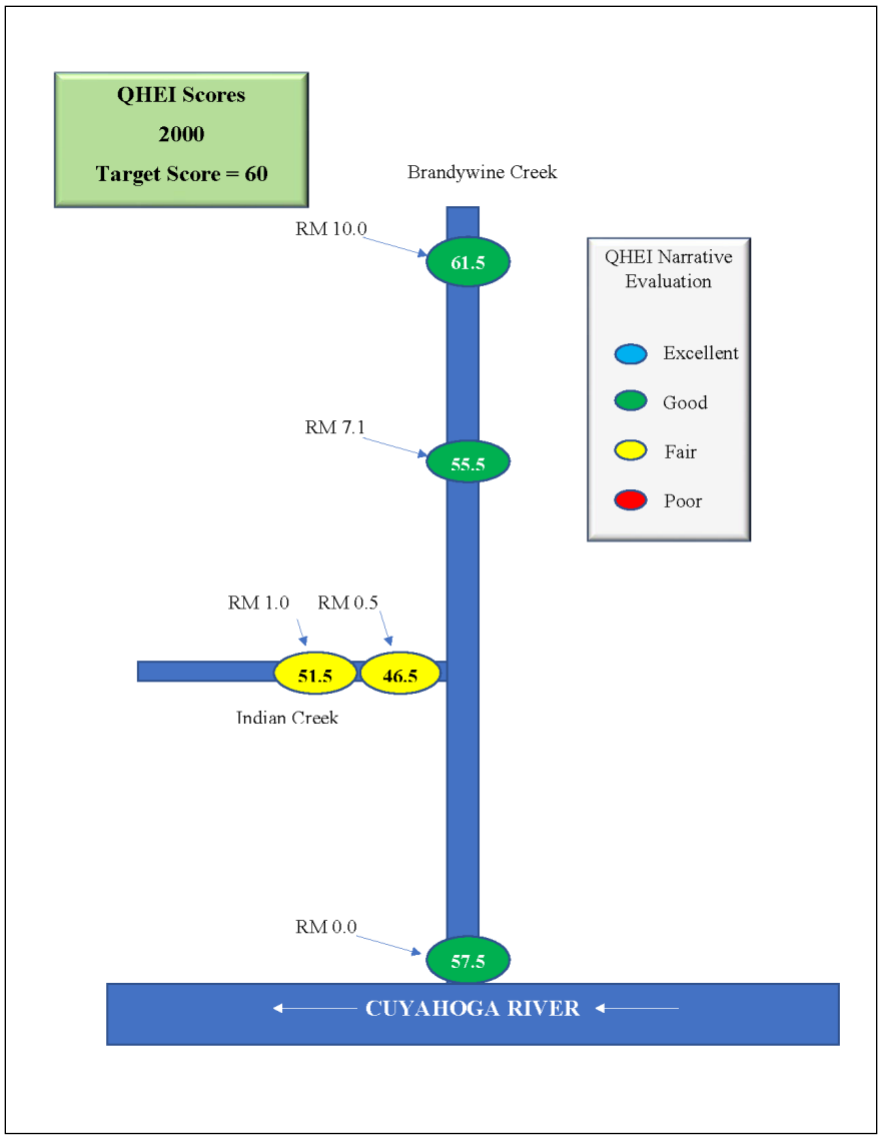

Figure 13: Brandywine Creek watershed Qualitative Habitat Evaluation Index Scores

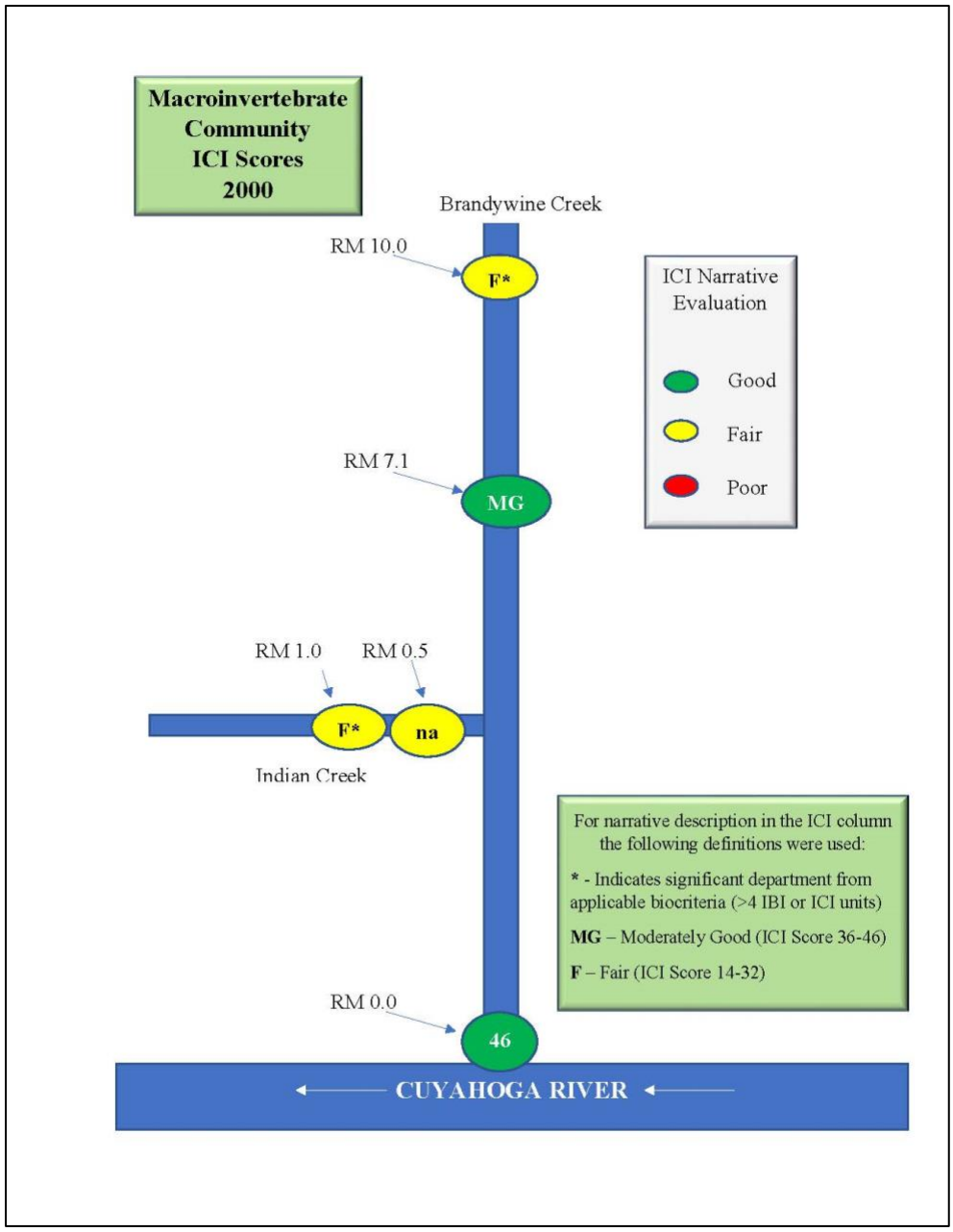

Figure 14: Brandywine Creek Watershed Invertebrate Index Scores

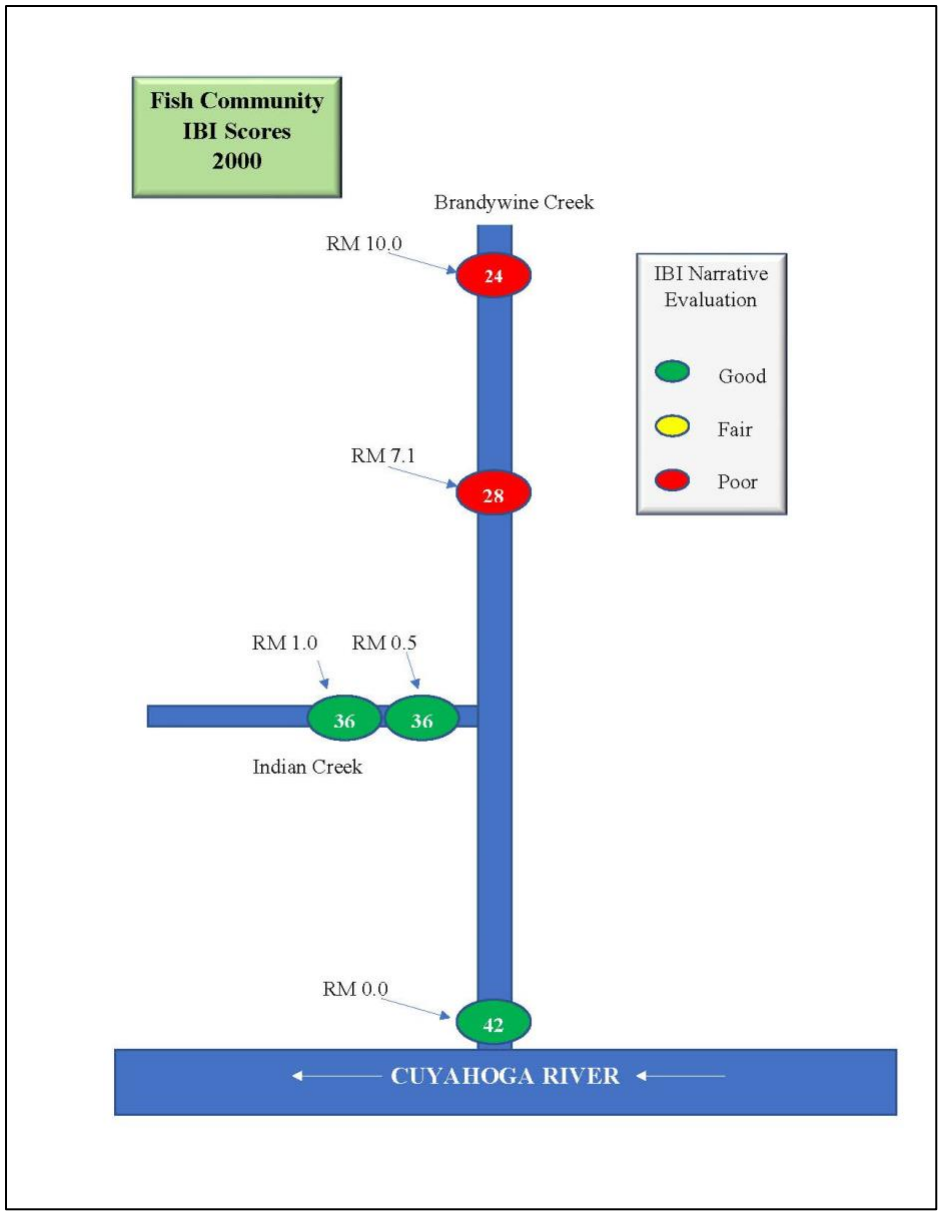

Figure 15: Brandywine Creek Watershed Index of Biological Integrity Scores

2.3 Summary of Pollution Causes and Associated Sources

The Ohio EPA's 2016 Integrated Water Quality Monitoring and Assessment Report has determined the cause(s) of impairment within the Brandywine Creek HUC-12 watersheds are as follows:

- Total dissolved solids
- Unknown toxicity
- Direct habitat alterations
- Nutrients
- Flow alternation
- Organic enrichment/DO

The major nonpoint source impacts in the watershed are a result of suburbanization and urbanization. Impacts associated with these sources include an increased sediment load to the streams, which result in decreased substrate heterogeneity and overall habitat quality. This is observed in Indian Creek and the Brandywine Creek main stem from its headwaters into Macedonia. Increases in impervious surface area also results in flashier stream flows which are partially responsible for channel incision and bank destabilization, both noted as occurring in the watershed.

Total Maximum Daily Load (TMDL) Pollutant Load Allocations – The following information provided is from the Lower Cuyahoga River TMDL, which was completed and finalized in September 2003*. The upper watershed has seen significant suburban development in the Hudson area and several new, highly eutrophic lakes have been constructed in the headwaters. Poor quality biological communities and enriched conditions were observed at Prospect Rd. (RM 10.0), downstream from Hudson and upstream from the former Hudson #5 WWTP. However, no obvious water quality problems were detected in water chemistry samples. Communities improved but remained impaired (Partial attainment) at Hines Hill Road (RM 7.1) and reached Full attainment (good quality) near the mouth. Conditions near the mouth were much improved compared to 1996 collections and Full attainment documented in 2000 was the first recorded by Ohio EPA in Brandywine Creek since sampling began in1984. Natural barriers to fish migration (waterfall) may inhibit recolonization of the stream above the waterfall.*

High conductivity levels encountered in 1996 near the mouth were not detected in 2000. The 1996 levels were traced as far upstream as Hudson. A specific source was not found but is believed to have originated from the Hudson WWTP. The Hudson plant was converted into a pump station in 1996 that directed waste to the NEORSD Southerly WWTP.

*Indian Creek is a small Brandywine Creek tributary that receives urban/suburban drainage from the Macedonia area. Fish communities were marginally good but macroinvertebrate communities were fair, resulting in Partial attainment. Numerous tolerant snails (*Physella*) and oligochaetes at RM 1.0 suggest an organic enrichment/DO problem but no obvious indications of sewage were observed on-site or in chemical sampling. Stream habitat in the lower mile was fair (Avg QHEI = 49) but this section of the stream is historically channelized and listed under maintenance by the Northeast Ohio Regional Sewer District.*

Based on attainment of the fish, lack of channel maintenance in the remainder of the basin, and adequate gradient (Avg.15.3 ft/mi.), the WWH use is recommended

Six (6) watershed stressors have been identified through the TMDL report: unknown toxicity, nutrients, organic enrichment/DO, flow alteration, direct habitat alteration, and total dissolved solids. Increased amounts of organic material in the system stem from loss of the riparian area, lawn clippings, and yard waste. Increased nutrients are speculated to be caused by loss of the riparian area, urbanization, use of lawn fertilizers, pet and wildfowl waste, and loss of a consistent tree canopy. Low levels of dissolved oxygen can cause a reduction in biological diversity. Decomposing organic material and high nutrient levels cause both algal blooms and corresponding decay when those plants die off, each of which depletes the water of oxygen – especially in the summer months. The input of non-point source pollution from the surrounding landscape coupled with the effluent discharges has created toxic conditions for biological species as well. The combination of several water quality degraders produces these toxic conditions.

In addition, Brandywine Creek experiences very high sediment loading caused from significant increases in storm water loading, which is correlated to the high amounts of developed land in the watershed (65.40%). Brandywine Creek watershed, like most urban watersheds, continues to experience a net loss of habitat both for terrestrial and aquatic species alike. The "unknown toxicity" alludes to a water quality degrader which is of unknown composition. Evidence of pharmaceutical compounds negatively influencing aquatic biology is being studied as a direct cause of the unknown impairments.

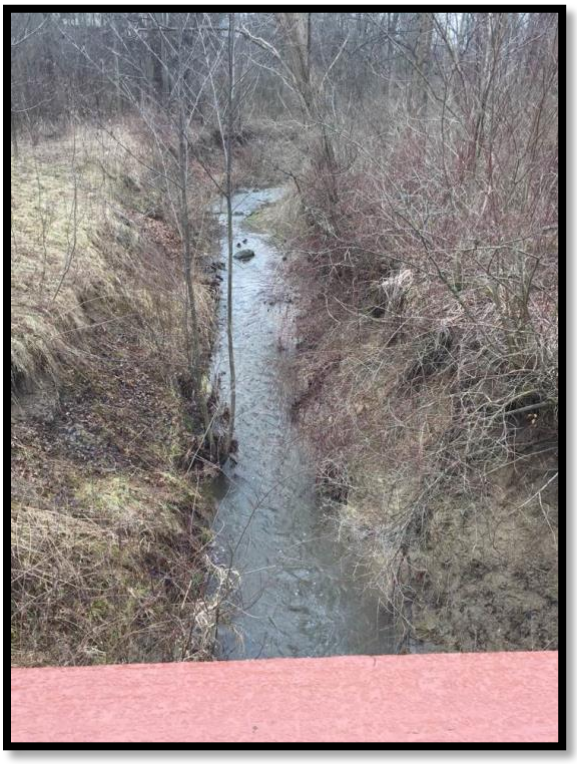

Figure 16: Looking upstream, inlet to Upper Lake Dam, Hudson, Summit County, the creek is incised here with eroding banks.

2.4 Additional Information for Determining Critical Areas and Developing Implementation Strategies

Tinkers Creek Watershed Partners have used several studies and survey feedback in order to determine the critical areas within the HUC-12 watershed. The groundwork for the critical areas was derived from the attainment and targeted delisting recommendation information from the Balanced Growth Plan (2014) and the Lower Cuyahoga Total Daily Maximum Load (September. 2003) documents. Although the data in these documents are older, TCWP used them to help narrow down known issues in the watershed.

The Ohio EPA's Water Quality Summary 2016 Integrated Report also provided relevant data and helped TCWP identify attainment issues and associated areas that had similar attainment issues. This information was paired with local knowledge of problem areas gathered from community interactions and through a survey sent to watershed communities and partners that work in the watershed. This helped to identify causes of impairments and potential projects.

Ohio EPA's *Support for the Development of Management Actions in Cuyahoga Area of Concern*, January 2017 by Tetra Tech was also utilized to determine the critical areas. The objective of this study was to develop lists of prioritized proposed management actions for the Cuyahoga AOC. The lists of proposed management actions within this document are considered "living documents". Ohio EPA plans to make revisions as data gaps are filled, new data becomes available, and as additional management actions are identified and implemented.

Table E-9. of the Integrated Report lists Brandywine Creek as "Waters for which the existing impaired status cannot be confirmed because data have become historical and not enough new data are available. These waters are category 5h".

The proposed management actions to remedy these impairments include removal of the barrier or impoundment, restore habitat (in-stream), and/or reconnect water resource and associated floodplain.

Chapter 3: Critical Area Conditions & Restoration Strategies

3.1 Overview of Critical Area

The following Critical Area has been identified based on local knowledge of issues, attainment status, geography, and impairments. Critical Area 1: **Upper Brandywine Creek HUC-12** (including main stem and other tributaries).

This critical area is heavily influenced by the priority conservation areas described in the Balanced Growth Plan. The BGP layered up critical soils, steep slopes, streams and natural riparian areas, floodplains, wetlands, and forests into a "critical natural features" map.

Critical Area 1 reaches across the middle belt of the watershed from northwest to southeast. It contains the bulk of the wetlands, forests, and critical soils that are a priority to protect and conserve.

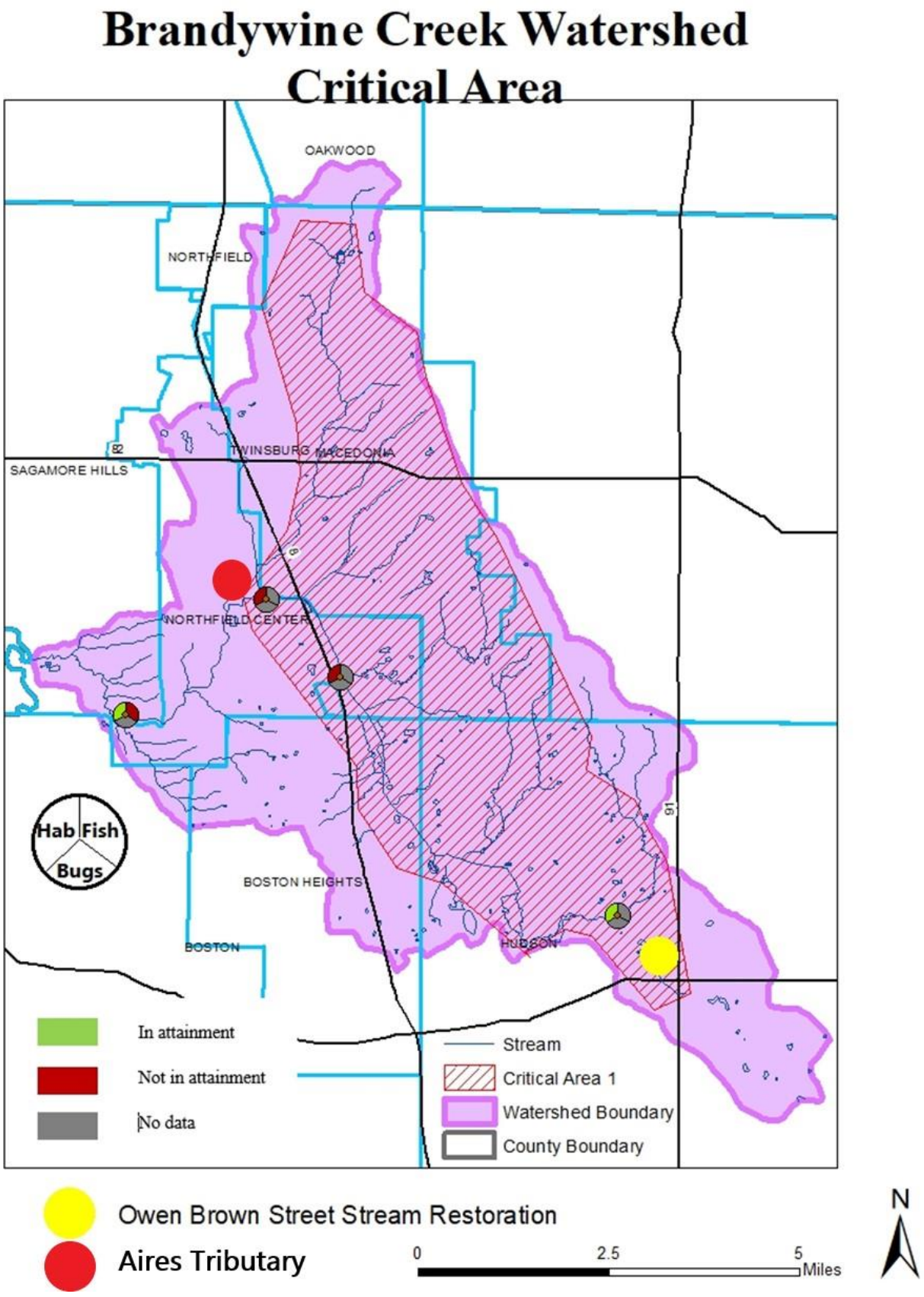

Figure 17: Critical Area 1 Brandywine Creek HUC-12, including potential projects and OEPA attainment monitoring sites

3.2 Critical Area 1: Conditions, Goals & Objectives

3.2.1 Detailed Characterization

Critical Area 1 encompasses the HUC-12 Brandywine Creek sub watershed. Within this critical area, the major causes of impairment are total dissolved solids, unknown toxicity, direct habitat alterations, nutrients, flow alteration, organic enrichment/DO. A TMDL has been developed for organic enrichment/dissolved oxygen, nutrients, siltation, habitat, and bacteria. Land use within this watershed is divided as follows: 65.40% developed, 27.30% forest, 4.90% grass/pasture, 0.30% row crops, and 2.10% other.

Critical Area 1 reaches across the middle belt of the watershed from northwest to southeast. It contains the bulk of the wetlands, forests, and critical soils that are a priority to protect and conserve.

Detailed assessments of headwater streams within the watershed are limited. It is fair to assume that the number of primary headwater streams (<1 square mile in drainage) has decreased since pre-settlement. These small streams are often lost due to development.

Figure 18: Brandywine HUC-12, example 'typical' of Critical Area 1

3.2.2 Detailed Biological Conditions

More sampling is recommended to further understand the biological conditions within this watershed. Changes to the watershed include increased stretches of channelized habitat and increased suburban development. The watershed is dominated by developed area which is no doubt having an effect on the aquatic life present.

This watershed has been identified to have an impaired Aquatic Life WWH. Several sources of this impairment have also been identified, including major municipal point source, combined sewer overflows, land development/suburbanization, urban runoff/storm sewers, and highway/road/bridge runoff (non-construction related)

More sampling within the Brandywine Creek watershed would provide insight into these impairments.

3.2.3 Detailed Causes and Associated Sources

Causes of Impairment:	**Sources of Impairment:**
total dissolved solids	major municipal point source
unknown toxicity	combined sewer overflows
direct habitat alterations	urban runoff/storm sewers
nutrients	land development/suburbanization
flow alteration	highway/road/bridge runoff (non-construction related)
organic enrichment/DO	

The Brandywine Creek headwaters originate in wetlands in Hudson. Habitat impairments reflect a historically dredged stream in various stages of recovery. Poor flow heterogeneity and a significant sediment load contribute to ecological impairments. Increased turbidity helps to limit fish community structure. Influences of rapid development with fair to poor storm water management become evident.

3.2.4 Outline Goals and Objectives for Brandywine Creek Critical Area 1

Brandywine Creek HUC-12: Erie-Ontario Lake Plain (EOLP) Warmwater Habitat, 27.06 mi^2.

The overall nonpoint source restoration goals for any NPS-IS plan are to improve IBI and QHEI scores so that the partial or non-attainment sites can achieve full attainment of the WWH designated aquatic life use for the respective water body.

Critical Area 1 reaches across the middle belt of the watershed from northwest to southeast. It contains the bulk of the wetlands, forests, and critical soils that are a priority to protect and conserve.

Specific goals applicable to non-attainment sites are outlined below:

Goal 1: Achieve an IBI score of at least 34 at Brandywine Creek at Prospect Road (RM 10.0).

NOT ACHIEVED: Site currently has an *IBI score of 24.*

Goal 2: Maintain a QHEI score of 61.5 at Brandywine Creek at Prospect Road (RM 10.0).

ACHIEVED: Site currently has a *QHEI score of 61.5.*

Goal 3: Achieve an IBI score of at least 34 at Brandywine Creek at Hines Hill Road (RM 7.1).

NOT ACHIEVED: Site currently has an *IBI score of 28.*

Goal 4: Achieve a QHEI score of at least 60 at Brandywine Creek at Hines Hill Road (RM 7.1).

NOT ACHIEVED: Site currently has a *QHEI score of 55.5.*

Goal 5: Maintain an IBI score of 36 at Indian Creek at Blue Jay Trail (RM 1.0)

ACHIEVED: Site currently has an *IBI score of 36.*

Goal 6: Achieve a QHEI score of at least 60 at Indian Creek at Blue Jay Trail (RM 1.0)

NOT ACHIEVED: Site currently has a *QHEI score of 51.5.*

Goal 7: Achieve an IBI score of at least 36 at Indian Creek at Highland Road (RM 0.5)

ACHIEVED: Site currently has an *IBI score of 36.*

Goal 8: Achieve a QHEI score of at least 46.5 at Indian Creek at Highland Road (RM 0.5)

ACHIEVED: Site currently has a *QHEI score of 46.5.*

For Critical Area 1, the following objectives have been developed to make progress toward achievement of the goals above:

Objective 1: Preserve and protect land along riparian areas and important natural features such as wetlands and fens from development through acquisition, conservation easements, and LID or conservation development.

- Protect 100 acres of riparian area along Brandywine Creek and its tributaries through acquisition or easements.

Objective 2: Restore in-stream habitat utilizing natural channel design to help create habitat and flood plain connectivity to support aquatic life.

- Restore and reconnect a minimum of 10,000 linear feet of stream.

Objective 3: Increase forest and understory cover protection along riparian areas through the adoption of riparian setbacks and enforcement by communities.

- Riparian setbacks adopted and/or enforced in 4 of 9 communities.

Objective 4: Restore vernal pools and other riparian wetlands in the Brandywine Creek Watershed.

- Restore 50 acres of vernal pools/wetlands/floodplains in Brandywine Creek.

Objective 5: Install or enhance native plantings

- Plant 50 acres of native species in riparian and/or wetland areas. Invasive species removal on these 50 acres will happen simultaneously.

Objective 6: Reduce sediment transport into Brandywine Creek through stormwater control measures and engineering methods

- Install green infrastructure to treat stormwater runoff from 75 acres.

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. For instance; many agricultural BMPs can be "stacked" (a systems approach) that will also incrementally improve the quality and quantity of runoff and drainage waters and in-stream water quality.

When reevaluating, the committee 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

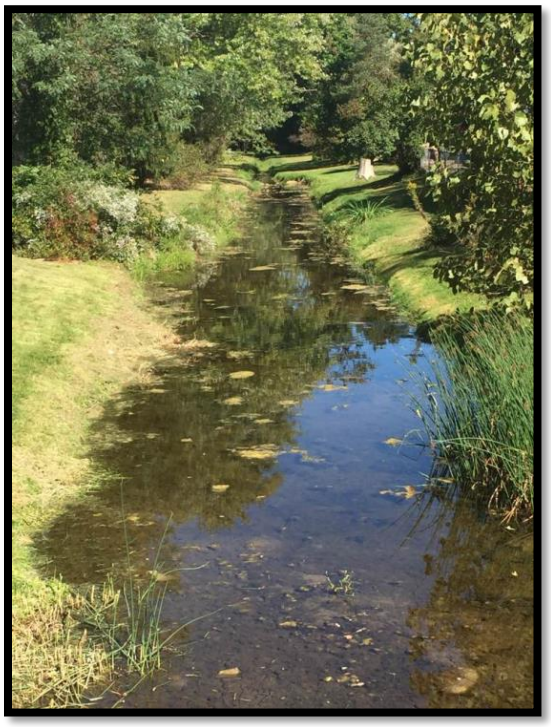

Figure 18: Brandywine HUC 12: Example of "typical" Critical Area 1

Chapter 4: Projects and Implementation Strategy

4.1 Projects and Implementation Strategy Overview Table(s) (Overview Table)

For *Brandywine Creek (HUC-12)* (04110002 04 04) —Critical Area 1								
Applicable Critical Area	**Goal**	**Objective**	**Project #**	**Project Title**	**Lead Organization**	**Time Frame**	**Estimated Cost**	**Potential/Actual Funding Source**
Altered Stream and Habitat Restoration Strategies								
1	1, 2,	1, 2, 3, 5	1	Brandywine Creek Stream Restoration at Owen Brown	TCWP	1-3 years	$225,950	Section 319, GLRI, USFWS grants
1	1,2	1,2,5	2	Aires Tributary of Brandywine Creek Stream Restoration Project	TCWP	1-3	$250,000	Section 319, GLRI, NEORSD, Aires Management
1	3,4	1,2	3	Brandywine Preserve HOA Riparian Restoration	TCWP	1-3 years	$311,837	Section 319, H2Ohio, NEORSD, GLRI

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).

Project #1 Summary Sheet

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Brandywine Creek Stream Restoration at Owen Brown- Project #1
criteria d	**Project Lead Organization & Partners**	Tinker's Creek Watershed Partners (TCWP) City of Hudson Northeast Ohio NEORSD
criteria c	**HUC-12 and Critical Area**	04110002 04 04 Critical Area 1
criteria c	**Location of Project**	41°14'48.29" N; 81°28'26.15" W
n/a	**Which strategy is being addressed by this project?**	Altered Stream and Habitat Restoration Strategies
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr.)
criteria	**Short Description**	This unnamed tributary of Brandywine Creek has numerous impairments from channelization, historic dredging, instream sediment loading resulting in water quality degradation, stormwater degradation, and adjacent urban land use. The entire reach is vertically entrenched, disconnected from an active floodplain, and lacks sinuosity. Streambanks heights average three to five feet throughout the reach due to down cutting and sidecast spoil piles from historic dredging. These issues result in water quality degradation, impacted habitat, and poor channel function. Because of these impairments, currently the habitat value of the stream as measured by the QHEI ranges between 53 and 56; and the bank erosion as measured by the BEHI is between high and very high.

criteria g	**Project Narrative**	The project area extends along an unnamed tributary of Brandywine Creek from the Owen Brown Street bridge north downstream for approximately 1,877 to the culvert crossing at West Prospect Street. The property owner is the City of Hudson and is protected by a conservation easement held by the Western Reserve Land Conservancy. Approximately 21 percent of the land in the watershed is forested; and 78 percent of the land is developed (urban) with 20 percent impervious surfaces. This reach of stream has been channelized, was historically dredged with soil sidecast along the banks, is downgrading and so is disconnected in many areas from the floodplain, has areas of high bank erosion, is pinched at the location of an old railroad bridge crossing, is receiving degraded water from a stormwater basin, and has a significant coverage of invasive, non-native vegetation. In spite of these impairments, much of the channel is vegetated with woody plants, it has a diversity of substrate types, there are locations of functional in-stream habitat, and there are areas of adjacent high-quality forested wetlands and uplands. The restoration plan for this reach of stream is focused on addressing the issues while at the same time, maintaining the high-quality conditions where they exist. That is, active construction activities have been minimized within high quality areas and where minimal in-stream issues occur. The restoration plan is aimed at reconnecting the stream to the adjacent floodplain and naturalizing the corridor where it is beneficial to help create habitat. The reach south of the railroad bridge has sufficient channel width but with the combination of downcutting and adjacent spoil piles, is disconnected from the adjacent floodplain. Grade control structures will be installed in the channel to raise the stream bed invert; and openings within the bank spoil piles will be excavated to allow hydrologic interaction with the floodplain. A railroad bridge crosses over the stream and is pinching the channel as is evidenced by the larger channel width up and downstream of the bridge, the adjacent erosion, and the undercutting of the sandstone bridge supports. The bridge will be removed, and the stream widened to a functional design width. Downstream of the bridge and the retention basin outlet, in-stream erosion increases. A new meandering channel with a raised stream bed invert will be excavated. The location of the new channel will be placed to avoid high quality wetlands (Wetland B). The adjacent floodplain area will be excavated to increase floodplain storage.

		All excavated material will be removed from the project area, outside of the floodplain. The culvert under West Prospect Street is undersized and is being eroded along the sides. Stone will be placed around the culvert to stabilize this area. Following completion of construction, all disturbed areas will be planted with native seed mixes appropriate to the proposed hydrologic regime. The entire project area has moderate, and in some areas, extensive invasive, non-native vegetation coverage. The streambanks are dominated by *Ligustrum vulgare* (privet), *Lonciera* spp. (bush honeysuckle), and *Rosa multiflora* (multiflora rose). Areas of the wetlands have only herbaceous cover consisting of *Phalaris arundinacea* (reed canary grass), *Typha* spp. (cattail species), *Phragmites australis* (common reed). Even in areas of higher quality, forested wetland and upland, the understory has populations of privet, honeysuckle, multiflora rose, and *Frangula alnus* (glossy buckthorn). Herbicide treatments of the undesirable vegetation will be implemented prior to construction activities, and for two years following construction. In addition, native woody plants will be installed throughout the project area. Specifically, live stakes will be planted along the streambanks where disturbances and bare soils occur. Bare root and container woody native plants will be placed in herbicide treated and excavated areas. The goal is to provide an environment where native species will thrive.
criteria d	**Estimated Total cost**	Final Design and Surveying: $60,715 Permitting/Ecological Assessment: $14,260 Construction (includes construction staking, materials, equipment, labor, excavation, dirt removal to adjacent site, construction oversight): $95,795 Invasive Plant Treatment/Control: $5,535 Native Plantings: $32,265 As-built plan: $7,380 Grant Administration: $10,000 **Total Cost: $225,950**
criteria d	**Possible Funding Source**	Section 319(h) grants, GLRI, and NEORSD.

criteria a	**Identified Causes and Sources**	Causes: Total dissolved solids, direct habitat alterations, nutrients, flow alternation, organic enrichment/DO Sources: Urban runoff/storm sewers, land development/suburbanization, highway/road/bridge runoff (non-construction related)
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	The goals for the receiving waters of Brandywine Creek at Prospect Road (RM 10.0) are to achieve an IBI score of at least 34 and maintain a QHEI score of 61.5. This location is the closest receiving water from the unnamed tributary within the project area. Addressing discussed issues within this tributary will provide refugia for biota as well as improved water quality to the receiving waters (Brandywine Creek.) Objectives within the project area are: **Objective 1**: Improve 1,890 l.f. of in-stream habitat and restore the natural flow utilizing natural channel design **Objective 2**: Reconnect a minimum of 1,890 l.f. of stream to the floodplain to restore the floodplain functions **Objective 5:** Enhance the nativeness of the riparian corridor with the planting of a minimum of 2.5 acres of native shrubs and trees and the control of a minimum of 3 acres of non-native, invasive vegetation.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	With respect to the goals for the project, the QHEI will be the main assessment tool as that will dictate the habitability of the channel for in-stream biota. The current QHEI score within the project area ranges between 53 and 56. The QHEI score is 4.5 to 7 points below the attainment index score of 60. It is expected that the restoration project will substantially improve the QHEI such that it will be at a 60 or better within a year of restoration. The BEHI will also be used as a monitoring tool to evaluate in-stream bank erosion. The bank erosion as measured by the BEHI is between high and very high. It is expected that the restoration project will substantially decrease bank erosion to a moderate or lower level within a year of restoration activities.
	Part 3: Load Reduced	251.5 pounds/year Nitrogen, 125.7 pounds/year Phosphorus, and 125.7 tons/year sediment will be removed as a result of this project.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	The QHEI and BEHI will be implemented yearly to determine if the project goals are being met to improve in-stream habitat and decrease sediment loading from bank erosion. Goal 1: Achieve a QHEI score of at least 60 Goal 2: Achieve a BEHI rating of moderate or better

criteria e	**Information and Education**	The project will be featured on the Hudson website and social media accounts of TCWP. In addition, information will be provided to the general public and local stakeholders and education/outreach will comply with all grant and funding source requirements (i.e., 1 fact sheet, 1 press release and 2 web articles). An interpretive sign will be installed on site.

Project #2 Summary Sheet

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Aires Tributary of Brandywine Creek Stream Restoration Project
criteria d	**Project Lead Organization & Partners**	Tinker's Creek Watershed Partners (TCWP) Village of Northfield Brandywine Creek HOA /Aires Management
criteria c	**HUC-12 and Critical Area**	04110002 04 04 Critical Area 1
criteria c	**Location of Project**	41.280024, -81.494740
n/a	**Which strategy is being addressed by this project?**	Altered Stream and Habitat Restoration Strategies
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr.)
criteria	**Short Description**	This unnamed tributary of Brandywine Creek has numerous impairments from channel adjustment, erosion, instream sediment loading resulting in water quality degradation, stormwater degradation, and adjacent urban land use. The entire reach is vertically entrenched, disconnected from an active floodplain, and lacks sinuosity. Bank heights averaged approximately 3.85ft above the streambed with an active floodplain height of 1.6 ft above the streambed. This results in flashy storm water events, erosion and stream bank incision, impacted habitat, and poor channel function. Because of these impairments, the bank erosion as measured by the BEHI indicated that a significant portion of the reach downstream of the site has instability. The cross-section analysis indicates a moderate entrenchment which is directly related to the reach's lack of active floodplain. Lastly, a hydraulic

		model generated in HECRAS indicated a disconnect between the channel and floodplain.
criteria g	**Project Narrative**	The project area begins 120 feet upstream of East Twinsburg Road and spans 2025 feet downstream, 71 feet downstream from the Count View Parkway crossing. The property owner is the Brandywine Creek HOA/ Aires Management. The Deer Path Lane neighborhood yard swale empties into the creek and were also evaluated, as well as, a tributary that flows north-west from Walter Road. This reach of the stream is plagued by erosion and channel adjustment at several locations. Cross section data shows a disconnect between the channel and the floodplain. Results of the preliminary study by EnviroScience, Inc indicate that due to the moderate entrenchment for the majority of the stream reach that small flashy storm events are becoming more common. The restoration approach for the proposed channel streambed is to raise grade and improve the relationship between the channel and floodplain. This will directly reduce erosion while maintaining stream function. The wider floodplain will be accessed more frequently and help store water thereby reducing downstream peak discharge and velocities. The creation of 11 riffles of variable length is needed to maintain the ideal streambed to floodplain relationship. The channel will be realigned to the north to create a new toe of slope. This will allow infill to restore approximate 2.5:1 bank slope. The toe of the slope with rip/rap builders to create stability. Branch layering and restored vegetation will provide both short-and-long term stability. Excavated material on the north bank will not only be used as slope infill but will also provide space for the new channel and the creation of a small floodplain. It is important that proper stream morphology is restored therefore areas will be reinforced with small boulders and cobble to create a pool through the stabilized areas. Riparian area will be restored and improved by the planting of native vegetation. The completed restoration project will be protected under Northfield Village's riparian setback ordinance

criteria d	**Estimated Total cost**	Final Design and Surveying: $35,000.00 Permitting/Ecological Assessment: $15,000.00 Construction (includes construction staking, materials, equipment, labor, excavation, dirt removal to adjacent site, construction oversight >1 yr): $185,000.00 Grant Administration $10,000.00 Native Plantings: $5,000.00 **Total Cost: $250,000.00**
criteria d	**Possible Funding Source**	Section 319(h) grants, GLRI, HOA/Aires Management and NEORSD.
criteria a	**Identified Causes and Sources**	Causes: Direct habitat alterations, nutrients, flow alternation Sources: Urban runoff/storm sewers, land development/suburbanization
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	The goals for this tributary to Brandywine Creek project are to repair connectivity between the channel and the floodplain. This primary goal will reduce the secondary issues of erosion and flashiness of stormwater. Addressing these issues will mitigate the issue of downstream instability by reducing the peak discharges and flow velocities plaguing the stretch. Additionally, a secondary goal is to achieve an IBI of 34 and a QHEI of 60 at the receiving waters of Brandywine Creek at Hines Hill Road. Objectives within the project area are: **Objective 1**: Raise the base elevation of 2,025 l.f. of stream to improve the relationship between the channel and the floodplain. **Objective 2**: Restore approximately 11 riffles of variable lengths based on stream pattern to provide vertical grade control and maintain the desired stream bed to floodplain relationship. **Objective 3:** Realign the channel to the north and create a new toe of slope. The toe would be treated with rip/rap boulders and branch layering and rested native vegetation to maintain stability. **Objective 4:** Create a new stream channel and small floodplain using excavated materials on the north bank.
	Part 2: How much of the needed improvement for the whole Critical Area is	With respect to the goals for the project, the QHEI will be the main assessment tool as that will dictate the habitability of the channel for in-stream biota. The current QHEI score within the project area ranges between 53 and 56. The QHEI score is 4.5 to 7 points below the attainment

	***estimated* to be accomplished by this project?**	index score of 60. It is expected that the restoration project will substantially improve the QHEI such that it will be at a 60 or better within a year of restoration. The BEHI will also be used as a monitoring tool to evaluate in-stream bank erosion. The bank erosion as measured by the BEHI is between high and very high. It is expected that the restoration project will substantially decrease bank erosion to a moderate or lower level within a year of restoration activities.
	Part 3: Load Reduced	33.1 pounds/year Nitrogen, 12.8 pounds/year Phosphorus, and 20.7 tons/year sediment will be removed as a result of this project.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	The QHEI and BEHI will be implemented to determine if the project goals are being met to improve in-stream habitat and decrease sediment loading from bank erosion. Goal 1: Achieve a QHEI score of at least 60 Goal 2: Achieve a BEHI rating of moderate or better
criteria e	**Information and Education**	The project will be featured on the Northfield Village website and on the social media accounts of TCWP. In addition, information will be provided to the general public and local stakeholders and education/outreach will comply with all grant and funding source requirements (i.e., 1 fact sheet, 1 press release and 2 web articles). An interpretative sign detailing the project will be displayed at the project site.

Project #3 Summary Sheet

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	*Brandywine Preserve HOA Riparian Restoration*
criteria d	**Project Lead Organization & Partners**	*Brandywine Preserve HOA & Tinkers Creek Watershed Partners*
criteria c	**HUC-12 and Critical Area**	*HUC 12 04110002 04 04 – Brandywine Creek. Critical Area #1*

criteria c	**Location of Project**	*The project is located along a small drainage tributary of Brandywine Creek within the Common Area of Brandywine Preserve Development, near 7390 Forest Cove Ln Northfield Village, Ohio 44067*
n/a	**Which strategy is being addressed by this project?**	Altered Stream and Habitat Restoration Strategies
criteria f	**Time Frame**	*Short-Term (Priority) (1-3 yr); Brandywine Preserve HOA along with Tinkers Creek Watershed Partners would like to apply for an Ohio EPA 319 grant or H2Ohio grant to fund the restoration of this project. The HOA has matching funds for the project and will place the project area within a conservation easement with Tinkers Creek Watershed Partners.*
criteria	**Short Description**	*Project is streambank restoration and floodplain erosion control along 1800 linear feet of Brandywine Creek unnamed tributary. This project is upstream of the West Creek Conservancy's Brandywine Creek Preserve. The project is estimated to reduce 146.8 ls/yr N & 56.5 lbs/yr P & 79.8 ton/yr of sediment.*
criteria g	**Project Narrative**	The project area extends along an unnamed tributary of Brandywine Creek from just west of Country View Pkwy to upstream for approximately 1,877 to the culvert crossing at E. Twinsburg Road and Walters Road. The property owner is the Brandywine Preserve HOA. Approximately 53.3 percent of the land in the watershed is forested; and 42.77 percent of the land is developed (urban) with 19.3 percent impervious surfaces. A 960 linear foot section of this stream reach has been channelized in the late 1990s during the first phase of construction of the residential development. The remaining stream section in this 10-acre area is in fair condition with a wide floodplain. In the channelized section, there are many areas of high bank erosion due to the channelization and the increased velocities of regional runoff from northern developments. Upstream development, through a stormwater culvert under E. Twinsburg Road, conveys stormwater through this 10-acre area. The proposed restoration plan for this reach of stream is focused on addressing the increased velocities from runoff while also maintaining the high-quality conditions where they exist. Therefore the restoration methods include natural flow reduction methods of beaver analogs, in-stream grade structures (rock riffles) and natural streambank stabilization techniques. Construction methods such as this will have minimal impact on existing forest, wetlands and soil compaction. The restoration is aimed at reconnecting the stream to the adjacent floodplain prior to entering the channelized section of the creek. Additional braided channel will be cut into the forest (non-wetland) floor to encourage the dissipation of flood flows.

		Downstream of the culvert on Country View Pkwy, the project will install rock rip rap. This additional rip rap will further dissipate the flood flows and stabilize the streambanks around the culvert. Following completion of the excavation and restoration, all disturbed areas will be planted with a mixture of native live stakes and wetland seed mixes appropriate to the proposed hydrologic regime. Specifically, live stakes will be planted along the streambanks where disturbances and bare soils occur.
criteria d	**Estimated Total cost**	*Project costs are estimated to be $311,837.00.*
criteria d	**Possible Funding Source**	*Ohio EPA 319, H2Ohio, NEORSD, GLRI*
criteria a	**Identified Causes and Sources**	*Causes: Direct habitat alterations, Nutrients, Flow alterations* *Sources: urban runoff/storm sewers, land development/suburbanization, road/bridge/highway*
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	The goals for the receiving waters of Brandywine Creek at RM 1.0 are to maintain an IBI score of at least 36 and achieve a QHEI score of 61.5 (existing is 51.5). Addressing issues within this tributary will provide refugia for biota as well as improved (nominal measurable improvement to QHEI in Brandywine Creek at RM1.0. Pre and post project monitoring at this project location should show dramatic improvement to WQ metrics. Objectives within the project area are: **Objective 1**: Protect riparian area along Brandywine Creek and its tributaries through acquisition or easements. This project will protect 10 acres, which is 10% of the goal for Critical Area #1. **Objective 2**: Restore in-stream habitat utilizing natural channel design to help create habitat and floodplain connectivity to support aquatic life. This project will restore and improve 1,800 LF of in-stream habitat through the installation of natural channel design beaver analog and braided stream channels which will improve floodplain aquatic life. This project will implement 18% of the goals for Objective 2 in Critical Area #1.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	*This project will complete 18% of the goals for Objective #2 and 10% for Objective #1.*

	Part 3: Load Reduced?	*The project is estimated to reduce 146.8 ls/yr N & 56.5 lbs/yr P & 79.8 ton/yr of sediment.*
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	Pre and post project monitoring will occur by OEPA (if project is funded through OEPA-NPS programs). RM 1.0 is monitored on a rotating basis as part of the Ohio's statewide stream monitiring program.
criteria e	**Information and Education**	*Tinkers Creek Watershed Partners will provide two (2) on-site restoration events during and after construction of the project. Additionally, there will be permanent educational sign installed on the property and the project will be posted onto the existing Tinkers Creek Watershed Partners website. The property will also be incorporated into the adjoining West Creek Conservancy's Brandywine Preserve where additional public education will be integrated.*

Appendix A: Acronyms and Abbreviations

A

ALU	Aquatic Life Use
AoC	Area of Concern

B

BGP	Balanced Growth Plan
BEHI	Bank Erosion Hazard Index

D

DSW	Division of Surface Water

E

EOLP	Erie-Ontario Lake Plains
EPA	Environmental Protection Agency

G

GPM	Gallons Per Minute
GLRI	Great Lakes Restoration Initiative

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
OEPA	Ohio Environmental Protection Agency
ORAM	Ohio Rapid Assessment Method

Q

QHEI	Qualitative Habitat Evaluation Index

R

RM	River Mile

S

SWCD	Soil and Water Conservation District
SR	State Route

T

TMDL	Total Maximum Daily Load
TSD	Technical Support Document
TCWP	Tinker's Creek Watershed Partner. Inc.

U

USDA	United States Department of Agriculture
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Services

W

WAP	Watershed Action Plan