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Version 1.0

TINKER'S CREEK

04110002 05 04 Town of Twinsburg (HUC 12)

Approved: August 8, 2017

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

Developed by:

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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. TCWP is also grateful to CLEB Collaborative for the online survey that was used to gather more information from community leaders and project partners living and working in the watershed. Some introductory portions of the plan were adapted from the initial *Tinker's Creek Watershed Action Plan* which was developed by Cuyahoga County Board of Health (CCBH) and Tinker's Creek Watershed Partners and endorsed by the Ohio EPA in 2008. The *Nine-Element Nonpoint Source Implementation Strategic Plan (NPS-IS Plan) Ottawa River-Frontal Lake Erie: Tenmile Creek HUC-12 (04100001 03 06)* 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: Babette Gowda and Jennie Brancho.

The Chagrin Valley Engineering Ltd. (CVE) team for GIS data acquisition and maintenance, the creation of the Stream Resource Database, the Urban Sub-watershed Initiative, impervious surface, canopy and other natural resource datasets.

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Chapter1: Introduction

This document addresses **Town of Twinsburg – Tinker's Creek HUC-12 (04110002 05 04)**. Tinker's Creek is the largest tributary to the Cuyahoga River with a watershed drainage area of 96.4 square miles. The main stem of Tinker's Creek is approximately 30-miles long and its watershed traverses four (4) counties in northeast Ohio (Portage, Geauga, Summit and Cuyahoga).

Town of Twinsburg – Tinker's Creek has a watershed drainage area of 55.53 square miles and drains areas in both Cuyahoga and Summit counties. Sub-watersheds included in this HUC-12 are Tinker's Creek Confluence, Wood Creek, Deer Lick Run, Tinker's Creek Gorge, Hawthorne Creek, Mud Creek, Beaver Meadow Run and Middle Tinker's Creek.

As State and Federal nonpoint source funding now relies upon the development of an NPS-IS plan, this NPS-IS plan must be 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 project implementation as we seek to address the impairments within Tinker's Creek watershed.

1.1 Background

This NPS-IS is an update to the fully endorsed *Tinker's Creek Watershed Action Plan June 2010* which incorporates all 3 HUC-12 watersheds. This document has provided a starting point for initial project implementation to improve and protect the waters of Tinker's Creek with an emphasis on critical areas within each HUC-12.

1.2 Watershed Profile & History

Tinker's Creek headwaters (Headwaters Tinker's Creek 04110002 05 02) begins in Franklin Township, Portage County meandering north to its confluence with the Cuyahoga River (Town of Twinsburg – Tinker's Creek 04110002 05 04) in the Village of Valley View. As it flows north the main stem of Tinker's Creek is fed by several tributary streams. One tributary, Pond Brook (HUC 12 - 04110002 05 01) begins in the City of Aurora at Pond Brook Lake flowing through Reminderville and heading south to its confluence with the main stem at the municipal boundary between the City of Twinsburg and Twinsburg Township.

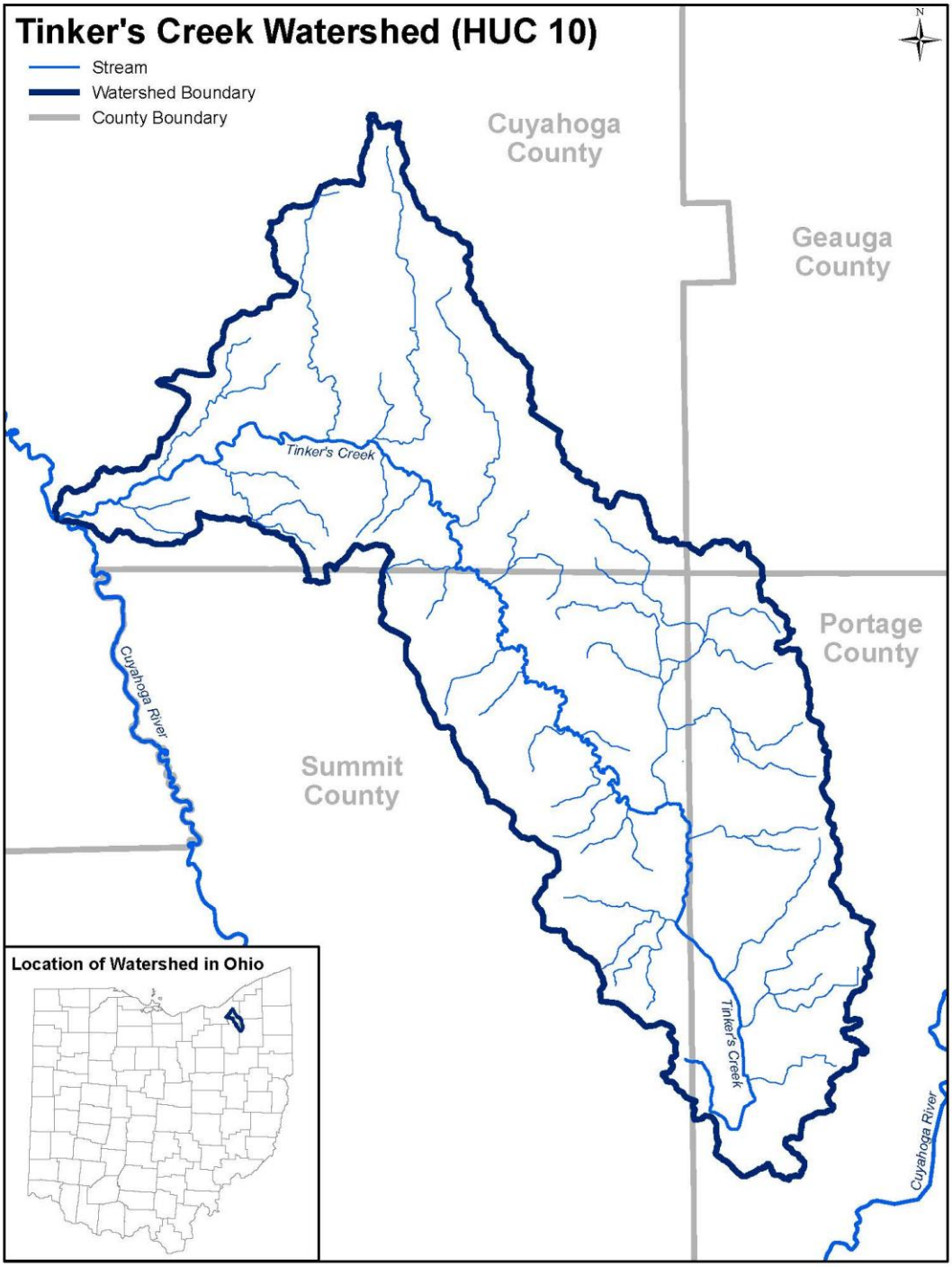

Figure 1: Tinker's Creek Watershed Location Map

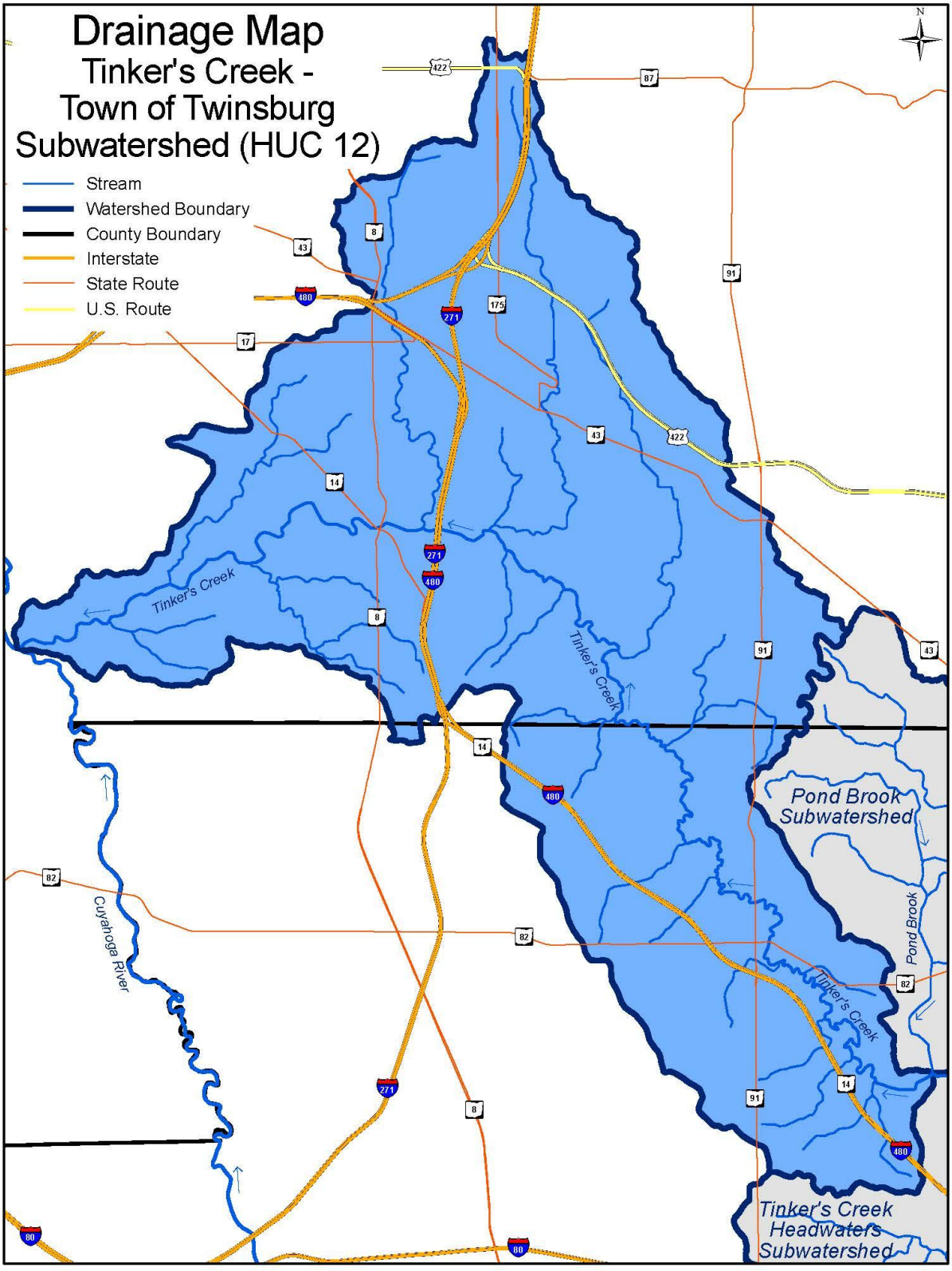

Figure 2: Town of Twinsburg – Tinker's Creek HUC-12 Watershed Location Map

Figure 3: Photograph of Tinker's Creek view looking downstream from Pettibone Road; Village of Glenwillow, Cuyahoga County

Prior to 1786, Ottawa Indians inhabited the watershed, specifically along the ridges adjacent to Tinker's Creek Road in Walton Hills and Valley View. However, as settler encroachment and westward expansion ensued, those Ottawa settlements disappeared. Shortly thereafter, a Moravian mission established itself. The pilgrims called it Pilgerruh or "Pilgrims Rest." In 1797, the Connecticut Western Reserve Land Company began to survey the land. A gentleman named Moses Cleveland lead the survey crew along with a Principal Boatman named Joseph Tinker. Because no convenient communication technology existed then, all documents and recordings were meant to be hand delivered. On a journey back to Connecticut, Joseph Tinker drowned in a boating accident. Out of homage to him and his dedicated work, Pilgerruh was renamed Tinker's Creek.

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 Tinker's 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 to which the Cuyahoga River flows too. Therefore, the Tinker's Creek watershed is an integral part of the process to "delist" the Cuyahoga River as an AoC.

Four (4) park districts have conserved land within the watershed, including the Ohio Department of Natural Resources Tinker's Creek State Park. In addition Cuyahoga Valley National Park and Cleveland Metroparks

Bedford Reservation meet at the confluence of the Cuyahoga River and Tinker's Creek. Bedford Reservation is the largest protected area within the watershed and contains a National Natural Landmark named Tinker's Creek Gorge, which includes a Scenic Overlook, Bridal Veil Falls, and the Great Falls of Tinker's Creek.

All 24 communities within the Tinker's 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). Tinker's Creek Watershed Partners are 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

The original watershed action plan was finalized by TCWP and endorsed by the state in 2010. Extensive input from community representatives, consultants, and agencies was utilized to identify water quality issues throughout the watershed. The WAP has been the organization's guiding document to implement planned projects and to help identify new projects. As projects were completed, TCWP remained in contact with communities to address arising concerns. At least once each year, TCWP met with each community to inquire about issues and followed up with them throughout the year. To further address needs within the watershed, TCWP has been communicating with agencies such as Ohio EPA, ODNR, and several park districts on water quality, protected lands, and potential projects.

In 2014, TCWP worked with community partners to solicit and identity new projects. These efforts included meeting with community leaders and consultants to identify problem areas in communities and possible solutions. Seven new projects were identified and conceptual plans were added to the WAP.

In order to ascertain the key challenges going forward and update the WAP to a Nine-Element Plan, TCWP utilized a survey that went out to community representatives and project partners throughout the watershed. The survey was sent to 154 individuals that ranged from municipal employees, project consultants, park districts, and local government agencies that work within the watershed. Along with the survey, TCWP requested potential project ideas from community members. Phase II updates were sent to the community watershed representatives each month from September 2016 to March 2017 with important information about the NPS-IS update process.

TCWP held our annual Mayors' Breakfast in March of 2017 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.

All this input from watershed partners has helped us to establish critical areas and projects that will help bring these areas into attainment. As the Nine-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

Tinker's Creek is the largest tributary to the Cuyahoga River with a watershed drainage area of 96.4 square miles. The main stem of Tinker's Creek is approximately 30-miles long and the watershed traverses across four (4) counties in northeast Ohio (Portage, Geauga, Summit and Cuyahoga).
Elevations in the watershed vary, with the highest elevation point being 1,200 feet above mean sea level and the lowest point lying at 620 feet above mean sea levels where Tinker's 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. Tinker's 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. Lower stream portions have carved the Tinker's Creek Gorge, which is listed as a National Natural Landmark within the National Park Service's program(Source: Ohio EPA, Division of Surface Water), (Source: *Kerr + Boron (Tinker's Creek Watershed Conservation Priority Plan*). 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 Tinker's Creek watershed, ranging from steep gorge areas where the river has cut its way down through bedrock to gentle slopes, flat areas, marshes, and wetlands. Rock outcroppings exist in several areas. The pattern of slopes within the watershed is gentle, with the steepest gradients found along the stream banks and where Tinker's Creek flows into the Cuyahoga River. Deeply incised and steep slopes define the valley and gorges nearer this confluence point, partially as a result of increased downstream erosion due to higher water flows and dredging of the 6.5 mile Cuyahoga Shipping Channel. 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. For example, many portions of the middle Tinker's have steep slopes that create waterfalls and other unique topographic areas.

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 is in their natural condition and are in Group D are assigned to dual classes. The predominant soil series in the Town of Twinsburg HUC-12 areas are as follows:

- Mahoning series – deep soils that are somewhat poorly drained and slowly or very slowly permeable; slope ranges from 0 to 6%
- Ellsworth series – deep soils that are moderately well drained and slowly or very slowly permeable; slopes range from 2 to 70%
- Urban land – nearly level and gently sloping areas that covered by asphalt, concrete, buildings and other impervious surfaces

- Wadsworth series – deep soils that are somewhat poorly drained with moderate to moderately slow permeability above the fragipan and slow or very slow permeability in the fragipan; slopes range from 0 to 6%

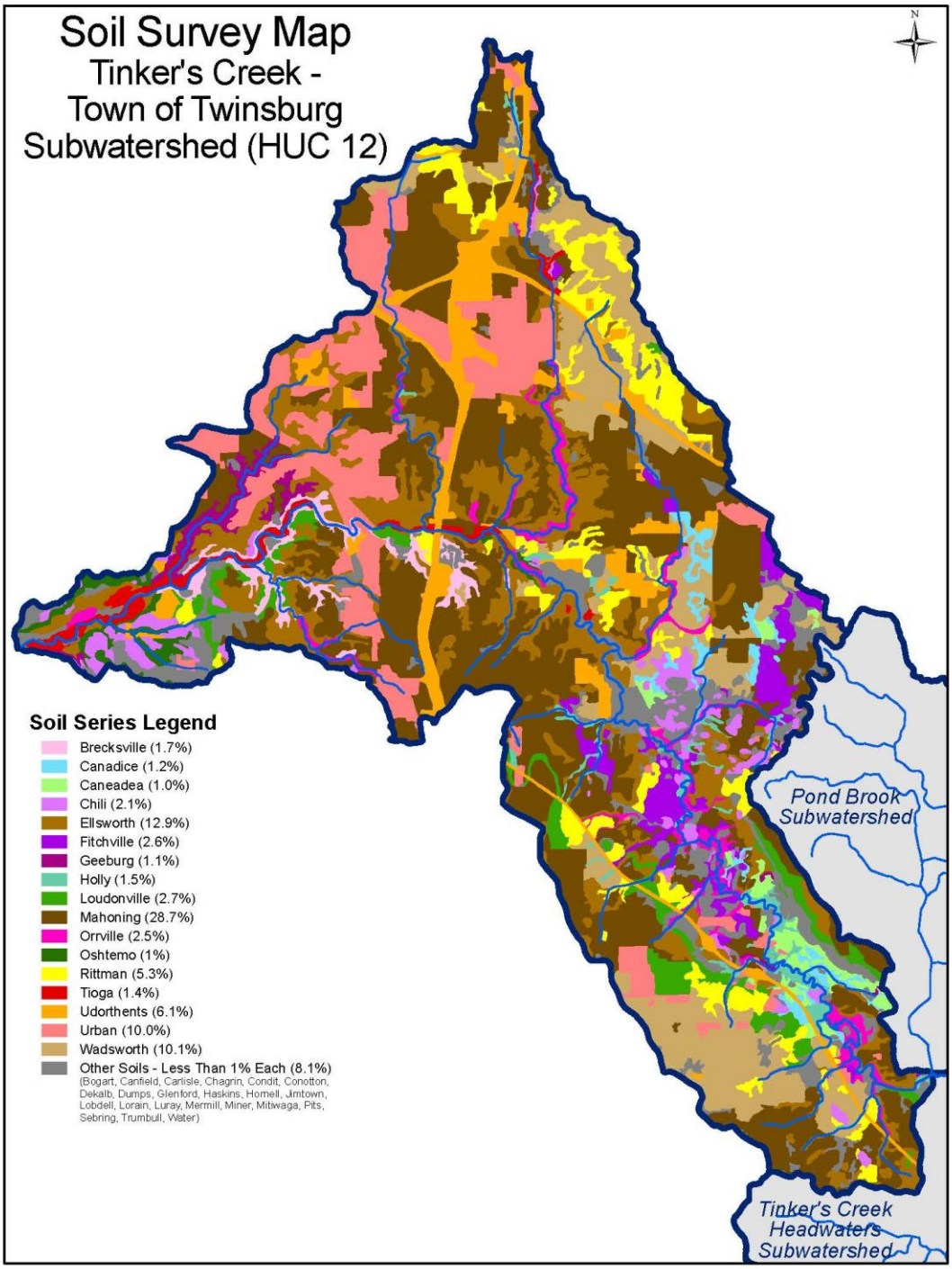

Figure 4: Town of Twinsburg-Tinker's Creek HUC-12 Underlying Soil Series Map

Tinker's Creek has a greater number and acreage of wetlands when compared to any other tributary in the lower Cuyahoga River area. Tinker's Creek contains approximately 951 wetlands or 3,917 acres of wetlands throughout the three (3) HUC 12 sub-watersheds in Tinker's Creek watershed. Like most other impacted watersheds, the range of wetland quality depends on the location within the watershed. The more urbanized locations in Tinker's Creek contain lower quality wetlands than areas that are currently developing or have not been developed yet. ORAM scores were deduced from previous field investigations performed by the Cuyahoga RAP, Davey Resource, and Enviroscience Inc. Clearly, a significant amount of moderate to high quality wetlands exists in the watershed; according to acres and number. Tinker's Creek has a relatively rich wetlands inventory, and consequently, a need to protect these important water resources.

In addition, the Tinker's Creek Wetland Prioritization Plan 2007/2008, shows all 951 wetlands have been identified. Of those wetlands, 421 are thought to be non-forested. Of the non-forested wetlands in the watershed, the total acreage for those identified is 2,224 acres.

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 Town of Twinsburg as identified by the NWI.

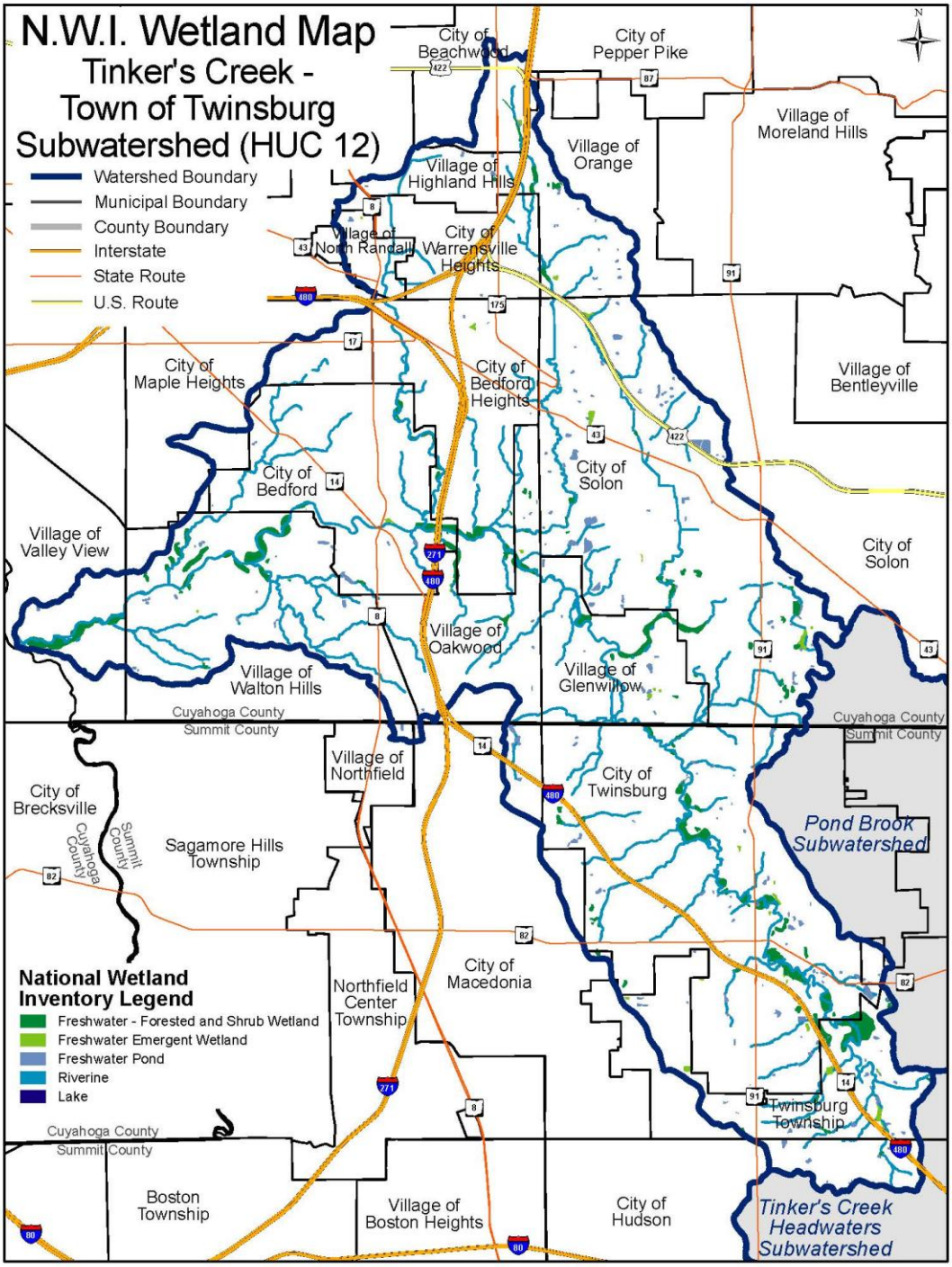

Figure 5: Town of Twinsburg - Tinker's Creek HUC-12 National Wetland Inventory Map

The Ohio Department of Natural Resources (ODNR), Division of Wildlife (DOW) maintains the Natural Heritage Database. A review of this database indicates there are 14 animals and 57 plants listed within the Tinker's Creek watershed (see Tables 1 and 2.).

Scientific Name	Common Name	State Status
Catocala gracilis	Graceful Underwing	Endangered
Childonias niger	Black Tern	Endangered
Myotis sodalis	Indiana Bat	Endangered
Opheodrys vernalis	Smooth Green snake	Endangered
Clemmys guttata	Spotted Turtle	Threatened
Gomphaeschna furcillata	Harlequen Darner	Threatened
Condylura cristata	Star-nosed Mole	Species of Concern
Etheostorna exile	Iowa Darter	Species of Concern
Hemidactylium scutatum	Four-toed Salamander	Species of Concern
Porzana carolina	Sora Rail	Species of Concern
Rallus limicola	Virginia Rail	Species of Concern
Gallinago gallinago (delicata)	(Wilson's) Common Snipe	Special Interest
Troglodytes troglodytes	Winter Wren	Special Interest

Table 1: State Listed Animal Species in Tinker's Creek watershed

Scientific Name	Common Name	State Status	Scientific Name	Common Name	State Status
Carex arctata	Drooping Wood Sedge	Endangered	*Carex lasiocarpa*	Slender Sedge	Potentially Threatened
Cornus canadensis	Bunchberry	Endangered	*Carex pallescens*	Pale Sedge	Potentially Threatened
Cypripedium parviflorum var. *parviflorum*	Small Yellow Lady's-slipper	Endangered	*Carex straminea*	Straw Sedge	Potentially Threatened
Galium labradoricum	Bog Bedstraw	Endangered	*Castanea dentata*	American Chestnut	Potentially Threatened
Hypnum pretense	Wrinkled-leaved Marsh Hypnum	Endangered	*Chamaedaphne calyculata*	Leather-leaf	Potentially Threatened
Juniperus communis	Ground Juniper	Endangered	*Corallorhiza maculate*	Spotted Coral-root	Potentially Threatened
Melampyrum lineare	Cow-wheat	Endangered	*Cornus rugosa*	Round-leaved Dogwood	Potentially Threatened
Myrica pensylvanica	Bayberry	Endangered	*Deschampsia flexuosa*	Crinkled Hair Grass	Potentially Threatened
Tomentypnum nitens	Fuzzy Hypnum Moss	Endangered	*Equisetum sylvaticum*	Woodland Horsetail	Potentially Threatened
Carex bushii	Bush's Sedge	Threatened	*Eriophorum viridicarinatum*	Green Cotton Grass	Potentially Threatened
Carex diandra	Lesser Panicled Sedge	Threatened	*Gentianopsis crinite*	Fringed Gentian	Potentially Threatened
Calopogon tuberosus	Grass-pink	Threatened	*Gentianopsis procera*	Small Fringed Gentian	Potentially Threatened
Corydalis sempevirens	Rock-harlequin	Threatened	*Geum rivale*	Water Avens	Potentially Threatened
Cypripedium reginea	Showy Lady's-slipper	Threatened	*Larix larcina*	Tamarack	Potentially Threatened
Elymus trachycaulus	Bearded Wheat Grass	Threatened	*Persicaria robustior*	Coarse Smartweed	Potentially Threatened
Epilobium strictum	Simple Willow-herb	Threatened	*Phegopteris connectilis*	Long Beech Fern	Potentially Threatened
Melanthium virginium	Bunchflower	Threatened	*Platanthera flava*	Tubercled Rein Orchid	Potentially Threatened
Potentilla palustris	Marsh Five-finger	Threatened	*Poa paludigena*	Marsh Spear Grass	Potentially Threatened
Rhododendron periclymenoides	Northern Rose Azalea	Threatened	*Potamogeton natans*	Floating Pondweed	Potentially Threatened
Salix candida	Hoary Willow	Threatened	*Prenanthes racemosa*	Prairie Rattlesnake Root	Potentially Threatened
Sisyrinchium mucronatum	Narrow-leaved Blue-eyed Grass	Threatened	*Rhynchospora alba*	White Beak-rush	Potentially Threatened
Solidago squarrosa	Leafy Goldenrod	Threatened	*Salix myricoides*	Blue-leaved Willow	Potentially Threatened
Sparganium androcladum	Keeled Bur-reed	Threatened	*Salix serissima*	Autumn Willow	Potentially Threatened
Viburnum alnifolium	Hobblebush	Threatened	Shepherdia canadensis	Canada Buffalo-berry	Potentially Threatened
Viburnum opulus var. *americanum*	Highbush Cranberry	Threatened	*Sphenopholis pensylvanica*	Swamp-oats	Potentially Threatened
Calla palustris	Wild Calla	Potentially Threatened	*Triantha glutinosa*	False Asphodel	Potentially Threatened
Carex alata	Broad-winged Sedge	Potentially Threatened	*Triglochin palustris*	Marsh Arrow Grass	Potentially Threatened
Carex bebbii	Bebb's Sedge	Potentially Threatened	*Zigadenus elegans*	White Wand-lily	Potentially Threatened
Carex flava	Yellow Sedge	Potentially Threatened			

Table 2 State Listed Plant Species within Tinker's Creek watershed

The U.S. Fish and Wildlife Service (USFWS) maintains a database of federally listed species that can occur within Ohio by County. For the four (4) Counties (Cuyahoga, Summit, Geauga and Portage) that Tinker's Creek watershed is present in. The USFWS indicates as follows: federally endangered - Piping Plover (*Charadrius melodus*), Kirtland's Warbler (*Dendroica kirtlandii*), Indiana Bat (*Myotis sodalis*), Mitchell's Satyr Butterfly (*Neonympha mitchellii mitchellii*); federally threatened - Northern Monkshood (*Acotinum noveboracense*), Rufa Red Knot (*Calidris canutus rufa*), Northern Long-eared Bat (*Myotis septentrionalis*) and Eastern Massasauga (*Sistrurus catenatus*).

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 Tinker's Creek watershed in its entirety (HUC-10). 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*), multiflora rose (*Rosa multiflora*) and Eurasian water milfoil. While present in the watershed, large scale impacts attributable to these species have not yet been investigated.

2.1.2 Land Use and Protection

Town of Twinsburg – Tinker's Creek HUC-12 has a watershed drainage area of 55.53 square miles and drains areas in both Cuyahoga and Summit counties with the following communities: Beachwood, Village of Highland Hills, Village of North Randall, Bedford, Bedford Heights, Warrensville Heights, Village of Orange, Maple Heights, Village of Valley View, Village of Walton Hills, Village of Oakwood, Village of Glenwillow and Solon (Cuyahoga County); Macedonia, Twinsburg, Twinsburg Township (Summit County).

The City of Cleveland is a historically industrial city. With the decline of the City beginning in the 1960s the adjacent ("inner-ring") suburbs, which include this watershed, experienced steady outward growth for decades. The Tinker's Creek watershed is fortunate in that it has protected lands at the federal, state, county, and local levels. Within the Town of Twinsburg-Tinker's Creek HUC-12 the National Park Service has protected lands at the mouth of Tinker's Creek within Cuyahoga Valley National Park which totals 380 acres. And Cleveland Metropark's Bedford Reservation has protected over 2,200 acres within the watershed. A portion of Cleveland Metropark's South Chagrin Reservation falls within this HUC-12. Land use within this HUC-12 is characterized as

the following: 73.20% developed, 20.90% forest, 4.50% grass/pasture, 0.30% row crop and 1.10% other (water) (Ohio Environmental Protection Agency Integrated Report, 2016).

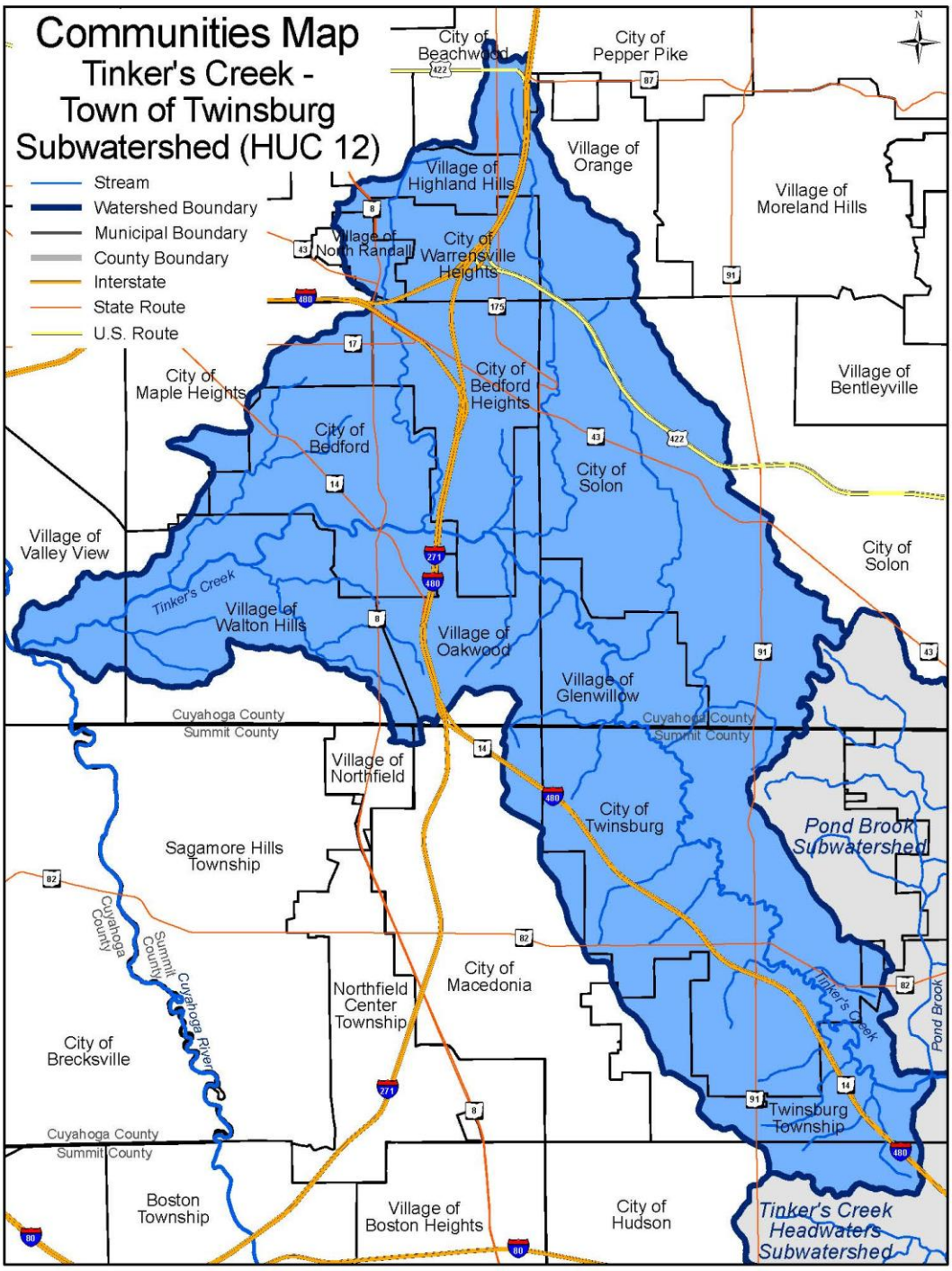

Figure 6: Town of Twinsburg – Tinker's Creek HUC-12 Community Location Map

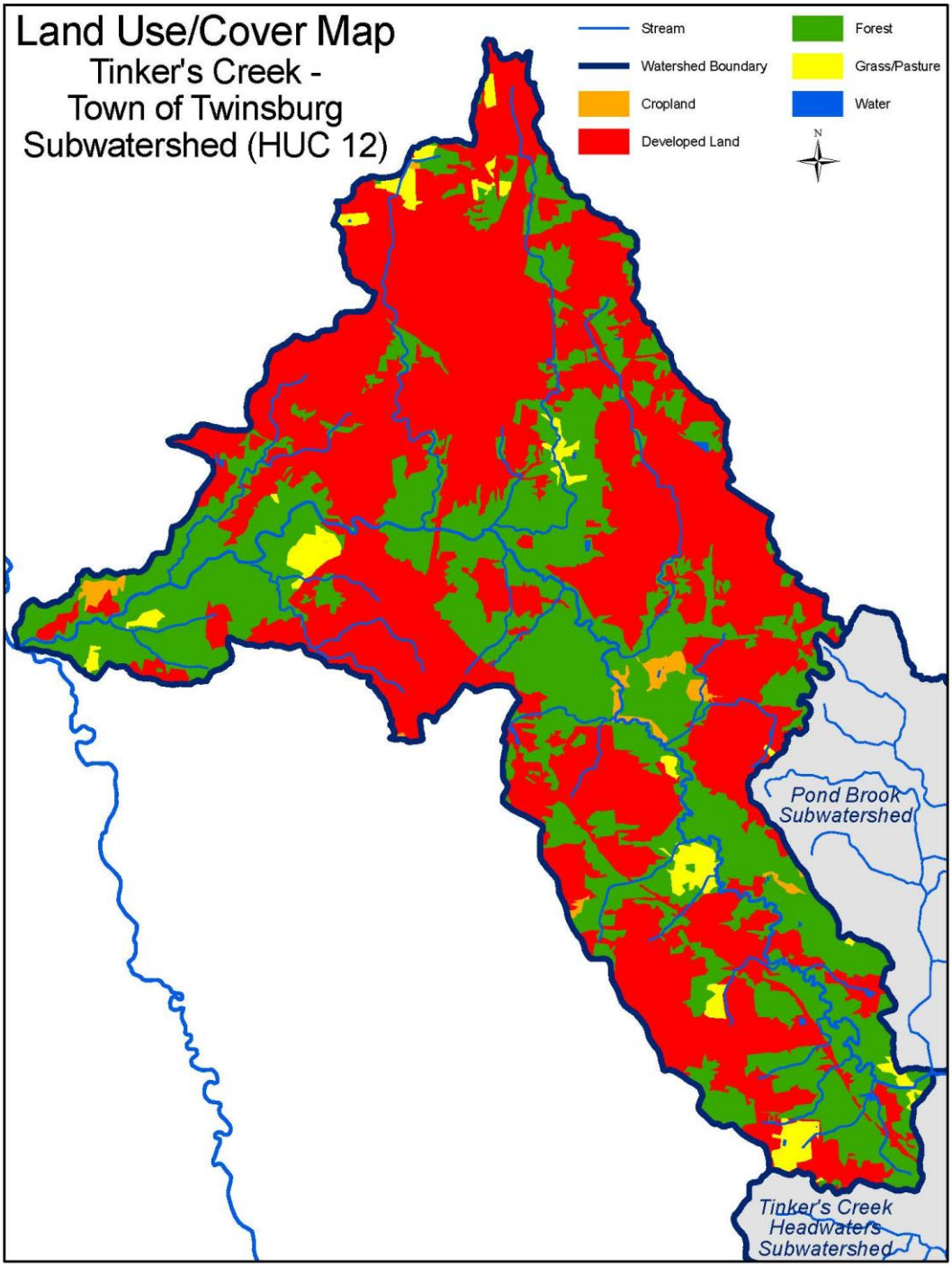

Figure 7: Town of Twinsburg - Tinker's Creek Land Use Map

Figure 8: Residential Land Use, Laurel Creek, Twinsburg, OH-Town of Twinsburg HUC-12

Figure 9: Forested Land Use-Town of Twinsburg HUC-12 (Bridal Veil Falls, Bedford Reservation)

Photo credit: William D. Dickinson

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 Tinker's Creek Watershed portion of the TMDL, several water quality issues were identified. Sedimentation, organic enrichment, low in-stream dissolved oxygen, nutrient enrichment, toxicity, habitat alteration, as well as yet to be determined impairments, were considered the main water quality issues facing Tinker's Creek. These unknown impairments could be contributed to the four (4) waste water treatment plant's (WWTP) which discharge into this watershed – they are located as follows: Bedford, Bedford Heights, Solon, and Twinsburg. Please see Figure 12: Tinker's Creek watershed Qualitative Habitat Evaluation Index Scores, Figure 13: Tinker's Creek watershed Invertebrate Index Scores and Figure 14: Tinker's Creek watershed Index of Biological Integrity Scores.

The majority of tributaries in this HUC-12 have a designated aquatic life use as warmwater habitat (WWH), however most are in non-attainment. Wood Creek is a small, urbanized, steep gradient (91ft/mi.) Tinker's Creek tributary. The headwaters receive urban drainage and wastewater from the Bedford WWTP and the lower reach flows through a park. Habitat quality at the mouth assessed utilizing the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) was a 62, a score that is adequate to support WWH communities. Nutrient levels (primarily nitrate) were elevated in 2000 and were determined to be related to the Bedford WWTP discharge.

The 1984 survey results show fish were absent from three (3) sites and macroinvertebrates were very low in density and diversity. The Ohio EPA 2000 305(b) reports results at the mouth showed slight improvement in fish Index of Biotic Integrity (IBI= 20/poor) and a significant increase in macroinvertebrate taxa (from 0 to 30). The 2016 Integrated Water Quality Monitoring and Assessment Report indicates studies in conducted in 2006 show the IBI scores at both sampling sites (Wood Creek downstream of Bedford WWTP near mouth; Wood Creek upstream Bedford WWTP) remain within the poor/very poor range while the QHEI scores held within the 60-point range (68 & 62 respectively).

The studies included in the Ohio EPA 2003 Lower Cuyahoga River Total Maximum Daily Load (TMDL) report indicate Deer Lick Run is a small, severe gradient (93 ft. /mile) tributary in the Tinker's Creek gorge. Waterfalls and shallow, glide-type flow on bedrock preclude the establishment of WWH fish communities and for these reasons the stream is designated LRW (Limited Resource Water). Primary Contact Recreation criterion for fecal coliform bacteria and WWH chemical/physical criteria were met. The Ohio EPA 2000 305(b) results indicated macroinvertebrates were fair but improved significantly when compared to the poor, toxic conditions found during a 1984 survey.

The studies included in the Ohio EPA 2003 Lower Cuyahoga River Total Maximum Daily Load (TMDL) report indicate Beaver Meadow Run is a small tributary to Tinker's Creek that receives the discharges from Zircoa, Inc. a company located in the City of Solon which manufactures zirconium oxide and aluminum oxide ceramic and refractory materials and products and the Solon Municipal WWTP. Zircoa, Inc. discharges to the very headwaters of Beaver Meadow Run and contributes high loads and concentrations of dissolved solids to the stream. The stream segment downstream from Zircoa, Inc. and upstream from the Solon WWTP was in non-attainment for both fish and macroinvertebrate communities in 2000. Zircoa, Inc. operates under industrial discharge permit number 3IE00014 and therefore discharges are regulated and monitored by the Ohio EPA.

The 2016 Integrated Water Quality Monitoring and Assessment Report indicates studies in 2006 show the IBI scores remain in the poor and fair ranges while the QHEI scores have improved to 77-points which places it within the excellent range.

Hawthorn Creek is a direct tributary to Beaver Meadow Run. The 2016 Integrated Water Quality Monitoring and Assessment Report indicates that Hawthorn Creek is in non-attainment of its designated WWH. Ohio EPA studies in 2006 and 2014 at four (4) monitoring locations show similar IBI scores in the poor and fair ranges. The QHEI scores show more varied with results, ranging from a score of 57 to 70.5.

The Ohio EPA 2000 305(b) reports indicated partial attainment in Tinker's Creek main stem which was an improvement over non-attainment in 1991. IBI scores ranged consistently within the Fair to Poor categories. The QHEI were more variable with low outlying score of 34.5, three (3) assessments sites attaining scores between 50-56 and three (3) with scores ranging from 71-78. As Tinker's Creek continues on its path towards the Cuyahoga River, an increasing amount of the watershed flows through protected areas and parkland with very little development in the riparian corridor. Gradient also increases allowing sediment transport to increase resulting in a more heterogeneous substrate. The Ohio EPA collected intensive biological community, chemical water quality, and physical habitat data in the assessment unit from 2006 to 2008. This undertaking was in support of ongoing efforts to determine effects of trace pharmaceuticals on biological communities and aquatic life use attainment status in the Tinker's Creek watershed. 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 4).

Sample Station Name	River Mile	ALU Type	Sampling Year	IBI Score	QHEI Score	MIwB Score
Tinker's Creek at Mouth @ Canal Rd	0.10	Full WWH	2008	38 (Good)	78	9.21 (Very Good)
Tinker's Creek Near Walton Hills @ Dunham Rd	2.18	Full WWH	2006	38 (Good)	74	7.68 (Fair)
Tinker's Creek UPST. Wood Creek ADJ Button Rd	2.50	Full WWH	2008	42 (Good)	69.5	8.29 (Good)
Tinker's Creek @ Metropark Bridle Trail	5.05	Partial WWH	2008	44 (Good)	80.5	7.29 (Fair)
Tinker's Creek at Bedford @ ST. RT 14	6.32	Non WWH	2006	20 (Poor)	88.5	6.26 (Fair)
Tinker's Creek near Bedford UPST Falls	6.50	Non WWH	2008	28 (Fair)	73	6.79 (Fair)
Tinker's Creek UPST. Bedford Heights	7.90	Non WWH	2008	20 (Poor)	83	5.77 (Poor)
Tinker's Creek 0.4 MI DST. IOOF Camp Bridge	10.20	Non WWH	2007	28 (Fair)	73.5	6.26 (Fair)
Tinker's Creek at Solon @ Pettibone Rd	11.24	Non WWH	2007	26 (Poor)	72.5	5.31 (Poor)
Tinker's Creek DST. Twinsburg WWTP @ E Idelwood Dr	14.32	Non WWH	2010	28 (Fair)	68.5	6.8 (Fair)

Tinker's Creek at Twinsburg @ ST RT 91	16.67	Non WWH	2006	32 (Fair)	50.5	6.79 (Fair)
Wood Creek DST. Bedford WWTP, Near Mouth	0.15	Non WWH	2006	12 (Very Poor)	68	N/A
Wood Creek Upst. Bedford WWTP	1.45	Non WWH	2006	20 (Poor)	62	N/A
Hawthorne Creek Just Dst. Bedford Heights WWTP	0.10	Non WWH	2006	24 (Poor)	67	N/A
Hawthorne Creek @ Richmond Rd.	0.75	Non WWH	2006	30 (Fair)	70.5	N/A
Hawthorne Creek at Bedford Heights @ Aurora Rd.	2.75	Non WWH	2014	26 (Poor)	57	N/A
Hawthorne Creek at Bedford Heights, Upst. Aurora Rd.	2.80	Non WWH	2014	24 (Poor)	58	N/A
Hawthorne Creek at Bedford Heights @ Cannon Rd.	3.44	Non WWH	2014	32 (Fair)	59.8	N/A
Beaver Meadow Run Dst. Solon WWTP @ Cochran Rd.	0.11	Non WWH	2006	22 (Poor)	77	N/A
Beaver Meadow Run Upst. Solon WWTP	1.20	Non WWH	2006	28 (Fair)	77	N/A

Table 3: Town of Twinsburg Tinker's Creek HUC-12, OEPA Aquatic Life Use Monitoring Sites

Some of the highest QHEI scores are found in the Tinker's Creek gorge, where a healthy riparian area dominated by larger sized substrate is present. Fish community study results from 2006-2008 found Tinker's Creek to be meeting Ohio's fish community standards at main stem sites below the falls. Water quality improvements in Tinker's Creek are partially responsible for this recovery as is the extremely good habitat and vast improvements in the Cuyahoga River, which is serving as a recruitment source.

Figure 10: Bear Creek, Town of Twinsburg HUC-12, after restoration in 2014

Figure 11: Bear Creek, Town of Twinsburg HUC-12, after restoration in 2014

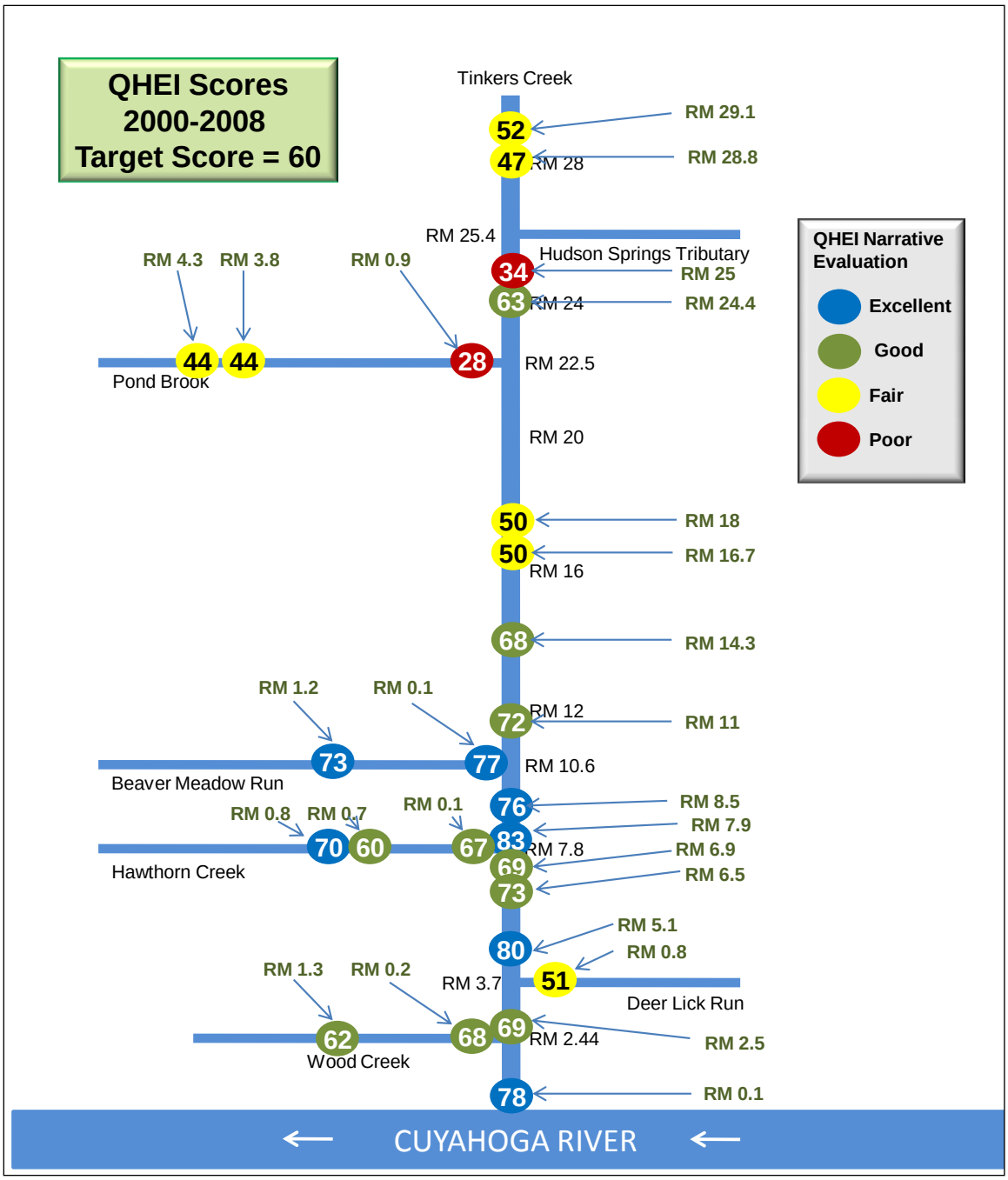

Figure 12: Tinker's Creek watershed Qualitative Habitat Evaluation Index Scores

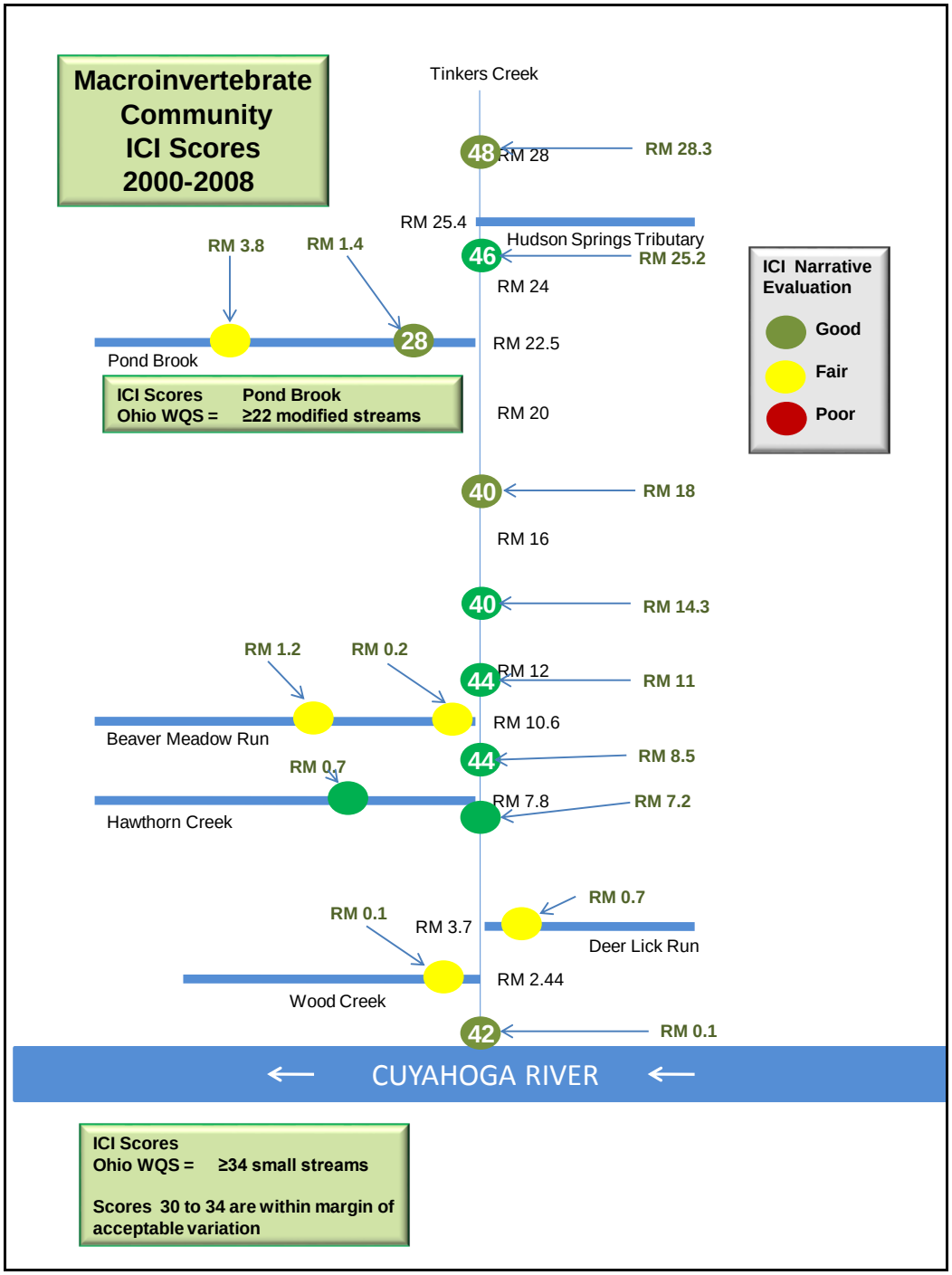

Figure 13: Tinker's Creek watershed Invertebrate Index Scores

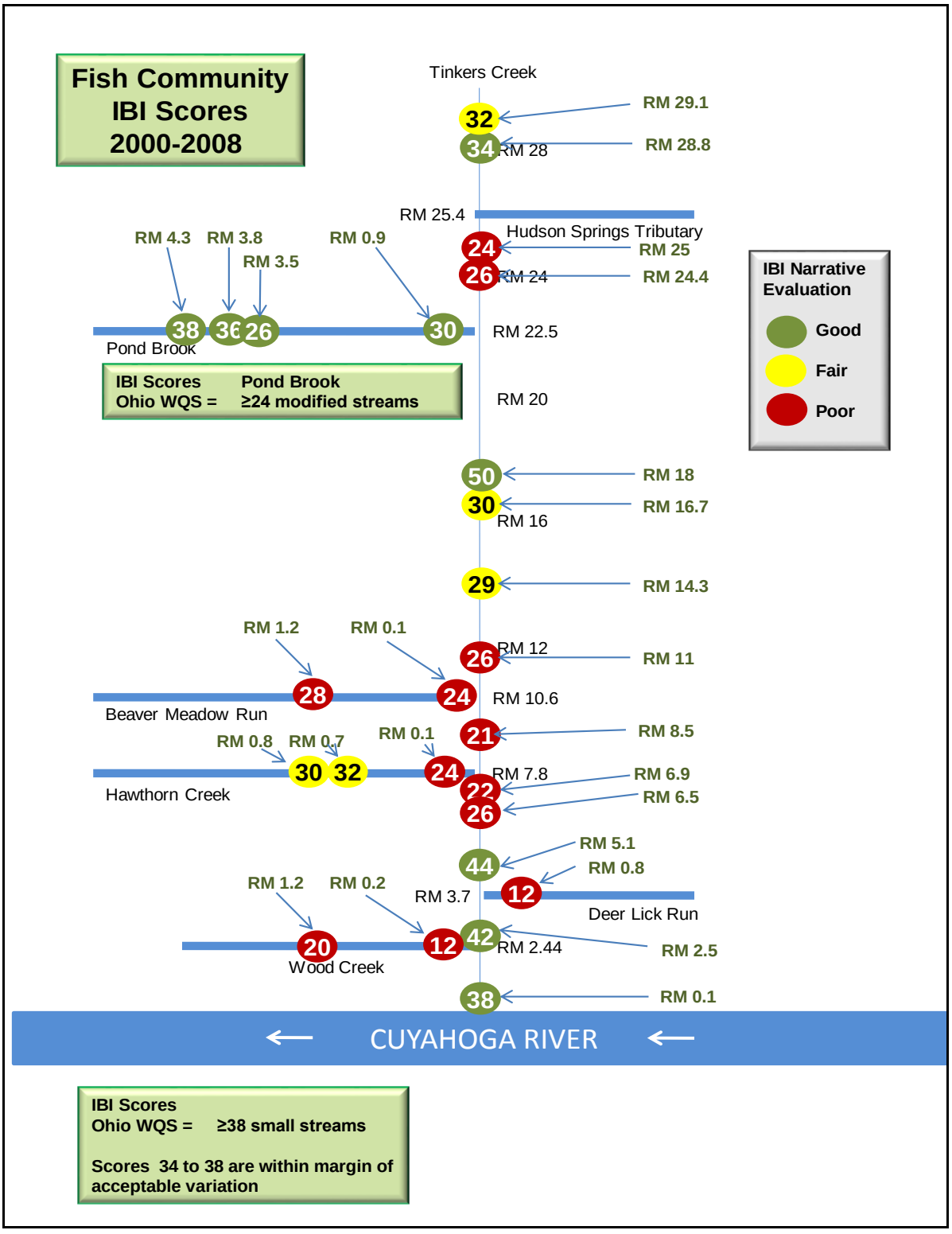

Figure 14: Tinker's Creek watershed Index of Biological Integrity Scores

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 Town of Twinsburg – Tinker's Creek watersheds as follows:

- Cause unknown
- Flow alteration
- Direct habitat alterations
- Organic enrichment/ Dissolved Oxygen
- Oil and grease
- Nutrients
- Natural limits (wetlands)
- Siltation

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 many smaller tributaries and the Tinker's Creek main stem from its headwaters into Twinsburg. Increases in impervious surface area also results in flashier stream flows which are partially responsible for channel incision and bank destabilization that is the main cause of siltation, 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. *Flows in the lower section of Tinker's Creek are highly influenced by the discharge of treated wastewater from upstream WWTPs. In 1991, the combined effluent had a median discharge of 11.623 mgd or 17.9 cubic feet per second (cfs). The 1996 Tinker's Creek water chemistry data collected at RM 0.1 showed no exceedances of WQS criteria. However, nitrate concentrations continue to be markedly elevated with a mean 6.81 mg/l compared to the 1991 mean of 7.6 mg/l. In contrast to lower Tinker's Creek, the median nitrate concentration from similarly sized reference streams in the EOLP ecoregion is 0.425 mg/l (n=298) (Ohio EPA 1999c). The excessive nitrates reflect the effluent dominated nature of the creek and improved ammonia nitrification at the major municipal WWTPs in the basin. These levels could limit biological potential in Tinker's Creek. Other factors, such as barriers to fish migration (i.e. waterfalls located downstream at RM 5.6), excessive turbidity, or other unknown causes and sources of impairment may contribute to the non-attainment.*

Eight (8) watershed stressors have been identified through the TMDL report: organic enrichment, nutrient enrichment, low in-stream dissolved oxygen, toxicity, sedimentation, habitat degradation, bacteria, and yet unknown impairments. 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, Tinker's Creek experiences very high sediment loading caused from significant increases in storm water loading, which is correlated to the high amounts of impervious cover in the watershed (21%). Tinker's Creek watershed, like most urban watersheds, continues to experience a net loss of habitat both for terrestrial and aquatic species alike. Low QHEI scores throughout most of the watershed are caused by loss of riparian areas, poor water quality, loss of connectivity to green corridors, and urbanization. The high bacterial levels in the watershed are caused by failing septic systems, Combined Sewer Overflows (CSOs), and non-point source pollution from impervious land cover. The "yet unknown impairments" allude 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.

Tinker's Creek is an effluent dominated stream and can consist of over 75% effluent during low-flow periods in the summer. The WWTP are the largest contributors of flow to the stream; other dischargers exist in the basin but are not included in this evaluation. Between 1960 and 1970, the basin saw an 83% increase in median stream flows, most likely due to population increases in the suburban communities, which resulted in increased flows to the wastewater treatment plants. Over the years, many improvements have been made at the individual plants, which have resulted in the high level of treatment and excellent compliance records seen today. This has resulted in improved macroinvertebrate communities generally meeting goals of the Clean Water Act. Fish communities in the watershed, namely tributaries and Tinker's Creek upstream of the natural waterfall, continue to show signs of impairment. In this case, the discharges from the plants are one of several factors considered responsible for the impairment.

The Ohio EPA in conjunction with USGS and the local communities with discharging WWTP's to Tinker's Creek have partnered to study the impact of effluent outputs from the plants to Tinker's Creek. Because Tinker's Creek has seven WWTP's within its drainage basin, it makes the watershed a unique study area for the impact of pharmaceuticals on aquatic species and biological diversity. The data is currently being analyzed and may provide insight into a growing issue which many water bodies will ultimately face. The study focuses on why fish populations are showing no improvement in the upper main stem while QHEI scores remain relatively stable. The increase of pharmaceutical and personal care products usage, and a growing population makes this study and future studies even more important to water quality initiatives. Elevated nutrients and turbidity are also being evaluated as possible stressors to this system.

Figure 15: Bear Creek, Town of Twinsburg HUC-12, showing in-stream erosion at culvert

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 watersheds. The groundwork for the critical areas was derived from the attainment and targeted delisting recommendation information from the Tinker's Creek Watershed Action Plan (2010) and the Lower Cuyahoga Total Daily Maximum Load (September. 2003) documents. Although the data in these documents is 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. Town of Twinsburg – Tinker's Creek HUC-12 does not meet the beneficial use impairment (BUI) for degradation of fish populations (#3a) and degradation of benthos (#6) but does meet for loss of fish habitat (#14a). Adjacent

Pond Brook HUC-12 meets the BUI for both degradation of fish populations and loss of fish habitat but does not meet the BUI for degradation to benthos. Adjacent Headwaters Tinker's Creek HUC-12 does not meet any of the BUI (3a, 6, 14a). 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 Areas

The following Critical Areas have been identified based on local knowledge of issues, attainment status, geography, and impairments in Town of Twinsburg – Tinker's Creek HUC-12 (including Middle Tinker's Creek, Beaver Meadow Run and Tinker's Creek Gorge East sub-watersheds)

Critical Area 1 is highly urbanized and is impaired by the issues that come with development and storm water issues. Many of the streams in CA1 are characterized as high gradient. This area still retains some high-quality wetlands and marsh areas due to land protection by conservancies and park districts. This area of the watershed is showing signs of impairment due to historic channel modification and suburban development. Increased runoff flow volumes due to watershed development causes channel destabilization resulting in lower QHEI scores. As the smaller streams are impacted more directly by localized development their scores decrease contributing to lower habitat quality at downstream sites. Conserving land from development is the most cost effective way to prevent future water quality degradation by ensuring that the natural resources which reside upon the land are protected.

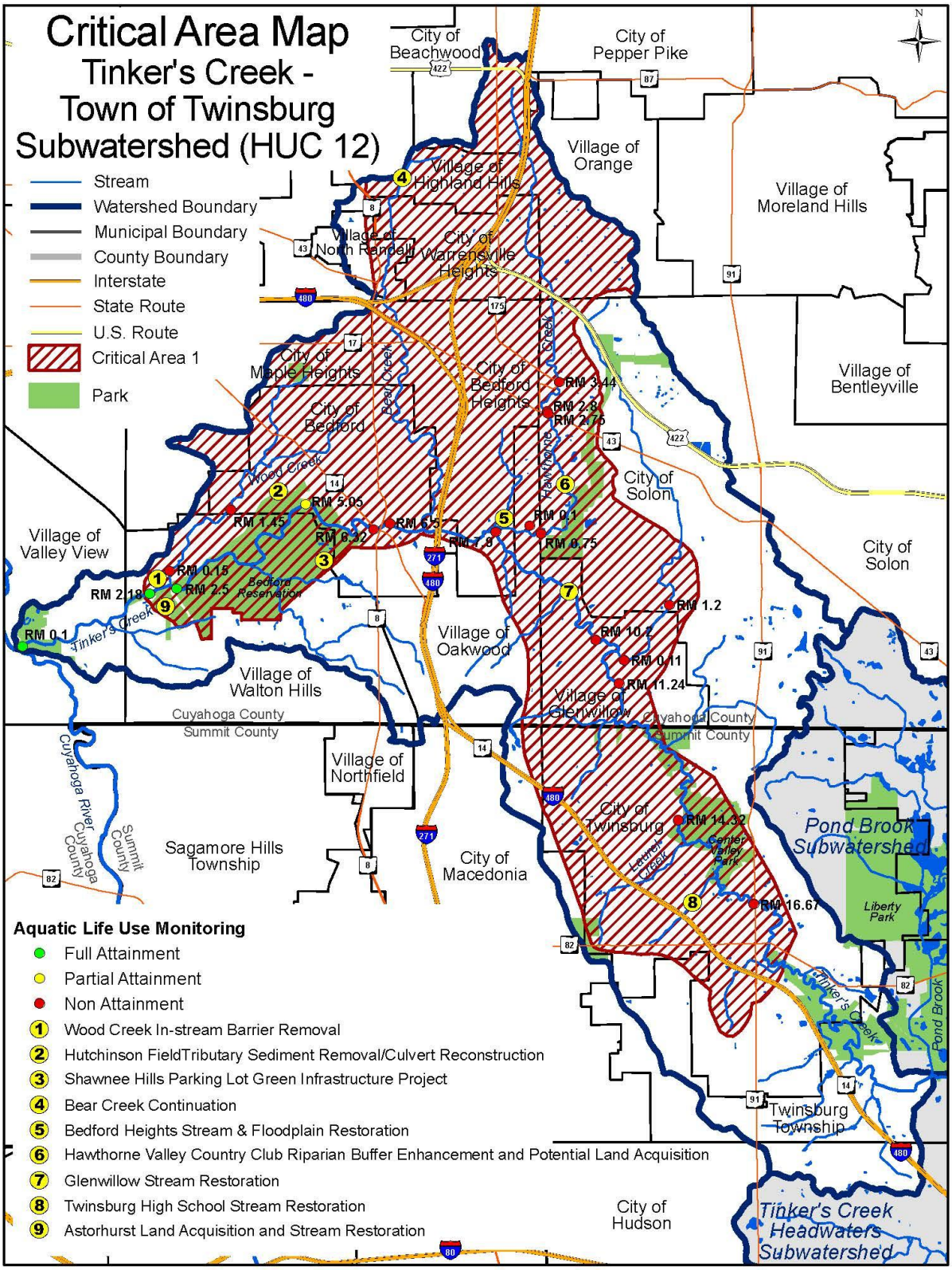

Figure 16: Critical Area 1 Town of Twinsburg HUC-12 including potential projects and OEPA attainment monitoring sites

3.2 Critical Area 1 Tinker's Creek-Town of Twinsburg HUC-12: Conditions, Goals & Objectives

3.2.1 Detailed Characterization

Critical Area 1 encompasses several sub-watersheds of the Tinker's Creek watershed, including all of the Beaver Meadow Run sub-watershed and parts of both the Tinker's Creek Gorge and Middle Tinker's Creek sub-watersheds. The major causes of impairment in this critical area include: bacteria. TMDLs for this critical area have been established for organic enrichment/dissolved oxygen, nutrients, siltation, habitat, and bacteria. The greater HUC-10 watershed that contains each of these sub-watersheds, the Town of Twinsburg – Tinker's Creek sub-watershed, contains the following land-use types: developed (73.20%), forest (20.90%), grass/pasture (4.50%), row crops (0.30%), and other (1.10%). In addition, this watershed includes two management actions in the January 2017 Cuyahoga Areas of Concern Management actions Report: They are the Village of Glenwillow Stream Restoration Project and Village of Oakwood Riparian Restoration Project.

Beaver Meadow Run: The Beaver Meadow Run sub-watershed covers a drainage area of 8.05 mi^2. 27.01% of the land cover in this sub-watershed is urban or impervious cover. There are 75 total wetlands within the Beaver Meadow Run sub-watershed, 4 of which are Category 2 and 71 that are not yet categorized. Beaver Meadow Run is a small tributary to Tinker's Creek that receives the discharges from Zircoa and the City of Solon municipal WWTP. Zircoa discharges to the very headwaters of Beaver Meadow Run and contributes high loads and concentrations of dissolved solids to the stream. The stream segment downstream from Zircoa and upstream from City of Solon WWTP was in non-attainment for both fish and macroinvertebrate communities.

Nutrient levels increased sharply, an ammonia violation was detected, and dissolved oxygen (D.O.) levels declined below the WWTP. The condition of fish (good) and macroinvertebrates (fair) resulted in Partial attainment downstream from the WWTP. Macroinvertebrate communities were predominated by nutrient tolerant forms. Species diversity and EPT taxa richness also tended to be lower below the WWTP than in other, similar small tributaries in the basin.

Partial attainments in 2000 were an improvement over Non-attainment in 1991. Positive changes appear the result of improved waste treatment and repair of a broken sewer line. Ultraviolet disinfection replaced chlorination at the WWTP in 1996.

Tinker's Creek Gorge and Middle Tinker's Creek (Tinker's Creek – Pond Brook to Cuyahoga River): The Tinker's Creek Gorge sub-watershed contains 79 wetlands, 34 of which are Category 3 and 45 of which remain uncategorized. The Middle Tinker's Creek sub-watershed has 166 wetlands: 6 Category 2 wetlands, 8 Category 3 wetlands, and 152 uncategorized wetlands.

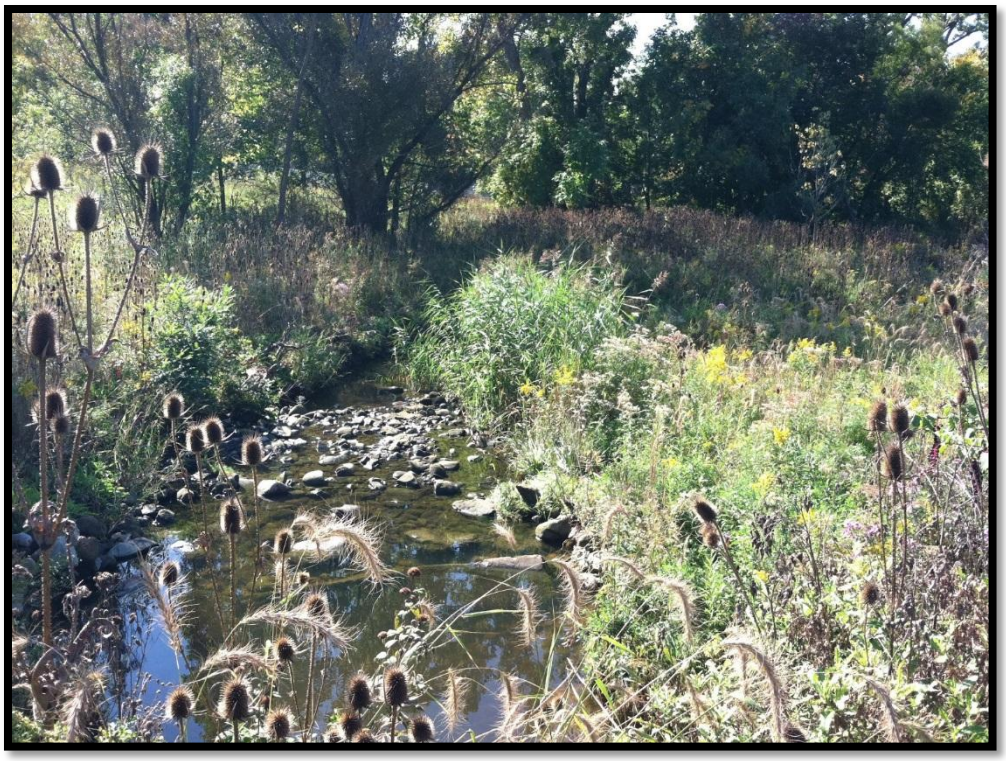

Figure 17: Town of Twinsburg HUC-12, photo 'typical' of Critical Area 1; Laurel Creek, Twinsburg

3.2.2 Detailed Biological Conditions

This critical area is within the HUC-12 watershed of the Town of Twinsburg – Tinker's Creek. The TMDL for this watershed found the aquatic life use to be impaired for both WWH and limited resource water. Data was collected on the intensive biological community, chemical water quality, and physical habitat between 2006-2008. These data collection efforts focused on determining the effects of trace pharmaceuticals on biological communities and aquatic life use attainment status in the watershed. The fish tissue assessment was also found to be impaired for this watershed.

Beaver Meadow Run: Fish within this sub-watershed were found to be in good condition, while macroinvertebrates were found in fair condition. These two factors resulted in the partial attainment of the beneficial use. However, the macroinvertebrate community was dominated by nutrient-tolerant species, and species diversity and EPT taxa richness decreased below the WWTP.

The most recent sampling data within this sub-watershed in Mud Creek (2006) found IBIs of poor to fair with scores of 22-28 and a QHEI score of 77. Four sampling sites within Hawthorne Creek in Beaver Meadow Run calculated IBIs of poor to fair with scores of 26-30 (2006) and 26-32 (2014) as well as QHEI scores of 67-70.5 (2006) and 57-59.8 (2014). In 2014, the invertebrate community was assessed and found to be in low fair to poor condition in two sampling sites.

Tinker's Creek Gorge and Middle Tinker's Creek (Tinker's Creek – Pond Brook to Cuyahoga River): Sampling within the Tinker's Creek Gorge sub-watershed in 2006 calculated an IBI of 20 (fair), MIWD of 6.26 (fair), and QHEI of 88.5. In 2007, the IBI at a different sampling site was 28 (fair), MIWB 6.26 (fair), and QHEI of 73.5. Two sites were sampled in 2008, with IBIs of 20-28 (poor-fair), MIWBs of 5.77-6.79 (poor-fair), and QHEIs of 73-83.

Middle Tinker's Creek was sampled at four sites between the years 2006-2008. Two sites were sampled in 2006, yielding IBIs of 29-32 (fair), MIWBs of 6.79-6.8 (fair), and QHEIs of 50.5-68.5. In 2007, the sampled site scored an

IBI of 26 (poor), MIWB of 5.31 (poor), and QHEI of 72.5. The final sampling site was found to have an IBI of 44 (good), MIWB of 7.29 (fair), and QHEI of 80.5 in 2008.

3.2.3 Detailed Causes and Associated Sources

Critical Area 1: Causes and sources of Impairments:

Causes of Impairment:	**Sources of Impairment:**
Cause unknown	urban runoff/storm sewers (NPS)
Flow alteration	source unknown
Direct habitat alterations	onsite wastewater systems (septic tanks)
Organic enrichment/ Dissolved Oxygen	natural
Oil and grease	major municipal point source
Nutrients	land development/suburbanization
Natural limits (wetlands)	
Sediment	Stream bank erosion

This section of Tinker's Creek continues to underperform in relation to the quality of its fish communities. Habitat is generally indicative of that which should support diverse fish populations. A natural waterfall on Tinker's Creek at RM 5.6 upstream from the Cuyahoga River does function as a natural fish migration barrier. Sections of the stream in the City of Twinsburg and City of Solon have heavy siltation and elevated turbidity which is contributing to the ecological impairments in the sub-watershed. Effluent from municipal wastewater treatment plants dominates the flow regime and elevated nutrients are present in the entire main-stem of Tinker's Creek. Smaller tributaries are impacted by urbanization.

The dominant habitat impairments in this critical area include a lack of riffles, highly/moderate riffle embeddedness, highly/moderate overall embeddedness, no fast currents, intermittent and poor pools, low sinuosity, fair/poor development, hardpan substrate origin, heavy/moderate silt, recovering channels, spare/no cover, no sinuosity, and silt/muck substrate. All of which leads to habitat impairments along this section of Tinker's Creek.

3.2.4 Outline Goals and Objectives for the Critical Area 1 in Town of Twinsburg HUC-12

Town of Twinsburg HUC-12: Erie-Ontario Lake Plain (EOLP) Warmwater Habitat, 55.53 square miles.

The overall nonpoint source restoration goals for any NPS-IS plan are to improve IBI and MIwb 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. Specific goals applicable to non-attainment sites are outlined below:

Goal 1: Achieve MIwb score of at least 7.4 at Tinker's Creek @ Metropark Bridle Trail (RM 5.05).

- Site currently has a *MIwb score of 7.29.*

Goal 2: Achieve IBI score of at least 34 at Tinker's Creek at Bedford @ St. Rte. 14 (RM 6.32)

- Site currently has an *IBI score of 20.*

Goal 3: Achieve MIwb score of at least 7.4 at Tinker's Creek at Bedford @ St. Rte. 14 (RM 6.32)

- Site currently has a *MIwb score of 6.26.*

Goal 4: Achieve IBI score of at least 34 at Tinker's Creek near Bedford UPST Falls (RM 6.5).

- Site currently has an *IBI score of 28.*

Goal 5: Achieve MIwb score of at least 7.4 at Tinker's Creek near Bedford UPST Falls (RM 6.5).

- Site currently has a *MIwb score of 6.79.*

Goal 6: Achieve IBI score of at least 34 at Tinker's Creek UPST. Bedford Heights. (RM 7.9).

- Site currently has an *IBI score of 20.*

Goal 7: Achieve MIwb score of at least 7.4 at Tinker's Creek UPST. Bedford Heights. (RM 7.9).

- Site currently has a *MIwb score of 5.77.*

Goal 8: Achieve IBI score of at least 34 at Tinker's Creek Dst. Twinsburg WWTP @E. Idelwood Dr. (RM 14.32).

- Site currently has an *IBI score of 28.*

Goal 9: Achieve MIwb score of at least 7.4 at Tinker's Creek Dst. Twinsburg WWTP @E. Idelwood Dr. (RM 14.32).

- Site currently has a *MIwb score of 6.8.*

Goal 10: Achieve IBI score of at least 34 at Wood Creek Dst. Bedford WWTP, Near Mouth (RM 0.15).

- Site currently has an *IBI score of 12.*

Goal 11: Achieve IBI score of at least 34 at Wood Creek Upst. Bedford WWTP (RM 1.45).

- Site currently has an *IBI score of 20.*

Goal 12: Achieve IBI score of at least 34 at Hawthorne Creek Just Dst. Bedford Heights WWTP (Rm 0.10).

- Site currently has an *IBI score of 24.*

Goal 13: Achieve IBI score of at least 34 at Hawthorne Creek at Richmond Rd. (RM 0.75).

- Site currently has an *IBI score of 30.*

Goal 14: Maintain IBI score of at least 34 at Tinker's Creek near Walton Hills @ Dunham Rd. (RM 2.18).

- Site currently has an IBI score of 38.

Goal 15: Maintain a MIwb score of at least 7.4 at Tinker's Creek near Walton Hills @ Dunham Rd. (RM 2.18).

- Site currently has a MIwb score of 7.68.

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

Objective 1: Preserve and protect land along the riparian area of Tinker's Creek and its tributaries through acquisition and/or conservation easements.

- Restore 530 acres of riparian area.

Objective 2: Increase forest and understory cover of Tinker's Creek main stem and tributaries.

- Plant 70 acres of riparian area.

Objective 3: 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 9,500 linear feet of stream in Tinker's Creek.

Objective 4: Restore Tinker's Creek tributaries by modifying in-stream habitat for fish passage.

- Remove 2 in-stream barriers.

Objective 5: Reduce urban runoff from impervious surfaces in Town of Twinsburg watershed communities.

- Treat stormwater from 5 impermeable acres using green storm water infrastructure techniques.

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: Town of Twinsburg HUC-12, map of potential land acquisition at Hawthorne Valley Country Club.

Chapter 4: Projects and Implementation Strategy

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

Below are the projects and evaluation needs currently believed to be necessary to remove the impairments to the Town of Twinsburg 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 positive or negative response in a reasonable time frame. But others may take longer to show recovery. There may also be reasons other than nonpoint source pollution for the impairment. Those issues well 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 project described in the Overview Table below have been prioritized using the following three step prioritization method:

Priority 1: Project specifically address one or more of the listed Objectives for the Critical Area.

Priority 2: Project where there is landowner willingness to engage in the project that is 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 Town of Twinsburg 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 *Town of Twinsburg (HUC-12)* (04110002 05 04) —Critical Area 1								
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)*
Urban Sediment and Nutrient Reduction Strategies								
1	4,5,6,7	1, 2, 3	5	Bedford Heights Stream & Floodplain Wetland Restoration at the Bus Garage	- TCWP - City of Bedford Heights	1-3 years Short	$213,865.67	Section 319, GLRI, USFWS grants
1	6,7	1, 2, 3	7	Glenwillow Stream & Floodplain Wetland Restoration	- TCWP - Village of Glenwillow	1-3 years Short	$1,560,195.02	Section 319, GLRI, USFWS grants
1	14, 15	1, 2, 3	9	Astorhurst Land Acquisition and Stream Restoration	-TCWP -Cleveland Metroparks	1-3 years Short	$4,600,000	Section 319, Clean Ohio Fund, GLRI
Altered Stream and Habitat Restoration Strategies								
1	8,9	1, 3	8	Twinsburg High School Stream Restoration	- TWCP - Twinsburg City School District - City of Twinsburg	3-7 years Medium	$169,573.50	Section 319, GLRI, USFWS grants SWIF grants
1	2,3,4,5	1, 2, 3	4	Bear Creek Stream Restoration – Phase III	- TCWP - City of Warrensville	1-3 years Short	$627,900.00	Section 319, GLRI, USFWS grants
1	4,5,6,7	1, 2, 3	5	Bedford Heights Stream & Floodplain Wetland Restoration at the Bus Garage	- TCWP - City of Bedford Heights	1-3 years Short	$213,865.67	Section 319, GLRI, USFWS grants
1	10,11	4	1	Wood Creek In-Stream Barrier Removal	-TCWP -Cleveland Metroparks	3-7 years Medium	$500,000	Section 319, GLRI, USFWS grants
1	1,2,3	5	3	Shawnee Hills Parking Lot Green Infrastructure	-TCWP -Cleveland Metroparks	3-7 years Medium	$350,000	Section 319, GLRI, USFWS grants

1	1	4	2	Hutchinson Field Tributary Sediment Removal/Culvert Reconstruction	-TCWP -Cleveland Metroparks	3-7 years Medium	$500,000	Section 319, GLRI, USFWS grants
1	12, 13	1,2,3	6	Hawthorne Valley Country Club Riparian Buffer Enhancement and Potential Land Acquisition	-TCWP -Cleveland Metroparks	3-7 years Medium	$11,000,000	Section 319, GLRI, USFWS grants
1	14,15	1, 2, 3	9	Astorhurst Land Acquisition and Stream Restoration	-TCWP -Cleveland Metroparks	1-3 years Short	$4,600,000	Section 319, Clean Ohio Fund, GLRI

4.2 Project Summary Sheet(s)

Project # 4 Summary Sheet

Nine Element Criteria	Information needed	Explanation
/a	**Title**	Bear Creek Stream Restoration – Phase III
criteria d	**Project Lead Organization & Partners**	Tinker's Creek Watershed Partners City of Warrensville Heights Biohabitats, Inc. – contracting service
criteria c	**HUC-12 and Critical Area**	04110002 05 04 Critical Area 1
criteria c	**Location of Project**	22411 Emery Road, Warrensville Heights, OH 44128 41.436609, -81.522250
n/a	**Which strategy is being addressed by this project?**	Altered Stream and Habitat Restoration Strategies Goals
criteria f	**Time Frame**	This restoration concept is intended to continue restoration efforts along Bear Creek in Warrensville Heights, Ohio, building upon the 2,000 linear feet that was restored in 2011 just upstream of this project. We have all the property owners lined up and all the initial design work completed this will be a short term project 1-3 years.
criteria	**Short Description**	Altered hydrology and damaged storm water outfalls deepened the stream bed and left steep streambanks. Phase II will repair a storm water outfall, redirect Bear Creek away from overhead utilities, create floodplain wetlands, create a floodplain bench, and restore native riparian vegetation.
criteria g	**Project Narrative**	TCWP contracted Biohabitats, Inc. to provide a restoration concept design and technical memorandum for this project. This project also entails working with Ohio DNR Division of Wildlife USFWS, U.S. Army Corps of Engineers, and the City of Warrensville Heights for permitting and identification of state/federally listed rare, threatened, or endangered species. Approximately 458 acres of the Bear Creek watershed is composed of dense residential development, open land with light commercial

		development, and woodland. The tributary reach to be restored begins at the damaged pipe outfall and headwall downstream of the Phase I restoration project and extends almost 800 feet downstream to Emery Road. This reach contains areas of bank erosion, damaged storm water outfalls with exposed vertical banks, channel incision (down cutting), and the absence of a functioning riparian floodplain. These conditions limit the biological communities and ecological services provided by the stream and are aesthetically unappealing. Riparian vegetation consists of mostly young trees and shrubs with herbaceous vegetation. In-stream habitat within this segment is rated at the high end of "Fair" with the upper reach scoring 59.75 and the lower reach scoring 53.5 on the QHEI. For Bear Creek, a QHEI score above 55 would indicate meeting warmwater habitat criteria. If left in its current condition, the Creek will likely continue to down cut and erode stream banks until reaching a point of equilibrium, while causing further erosion, habitat loss, increased sedimentation downstream, and reduced water quality, further jeopardizing infrastructure such as storm sewer outfalls. To address existing issues, the conceptual design shows a rehabilitated Bear Creek relocated away from the existing overhead utilities, allowing floodplain wetlands creation in the old channel and the floodplain bench gradation. This concept also shows the restoration of native riparian woody vegetation along the floodplain to slow overland flow, capture woody debris, and process nutrients and sediment from the channel. In addition, the damaged storm water outfall would be repaired and stabilized. Restoration and stabilization of this reach of Bear Creek will result in measurable improvements in the stream, floodplain, and riparian habitat like those listed below. - Approximately 800 feet of stream channel restored and stabilized - Nearly 1,500 feet of poor quality stream bank regraded/relocated and stabilized using native plants and bioengineering techniques - Roughly 0.86 acres of degraded forest converted to native floodplain shrubland and native riparian forest, 0.22 acres of maintained lawn replaced with native riparian forest, 1.61 acres of existing riparian forest enhanced, and 0.07 acres of wetland created - Raising the QHEI score to 60 within five years after the restoration has been completed

criteria d	**Estimated Total cost**	Sub-contractual: Construction costs assume that no hazardous waste will be identified during the design phase and that hazardous material will not need to be removed during construction. They also assume that soil amendments and the removal of unsuitable material (such as concrete debris) will be minimal and that utility repair or relocation is unnecessary. The concept-level opinion of probable cost for final design, permitting, and construction is shown below: - Final Design and Permitting - $80,000 - Construction Administration (including planning and administration) - $37,000 - Mobilization, Site Preparation, and ESC - $45,000 - Grading, Structures, and Site Stabilization - $243,000 - Planting - $63,000 - Post-Construction Monitoring (3 years) - $15,000 - Contingency (30%) – 144,900 - **Total Construction Costs: $627,900.00**
criteria d	**Possible Funding Source**	Section 319(h) grants, GLRI, USFWS grants
criteria a	**Identified Causes and Sources**	Causes of impairment: • Nutrients • Direct habitat alterations • Siltation • Flow alteration Sources of impairment: • Streambank modification • Land development/suburbanization • Urban runoff/stormwater • Removal of riparian vegetation

criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	With the goal being to achieve an IBI score of at least 34 at Tinker's Creek near Bedford UPST Falls (RM 6.5), with a current IBI score of 28, and also to achieve a MIwb score of 7.4,currently 6.79 at Tinker's Creek near Bedford UPST Falls (RM 6.5); and also to achieve an IBI score of at least 34 at Tinker's Creek Bedford @ St. Rte 14 (RM 6.32), currently the site has a score of 20, and also to achieve a MIwb score of at least 7.4 at site (RM 6.32) which has a score currently of 6.26, reasonable objectives are: **Objective 1:** Preserve and protect land along the riparian area of Tinker's Creek and its tributaries through acquisition and/or conservation easements. • Restore 530 acres of riparian area. **Objective 2**: Increase forest and understory cover of Tinker's Creek main stem and tributaries. • Plant 70 acres of riparian area. **Objective 3**: 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 9,500 linear feet of stream in Tinker's Creek.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	• 40 acres of the 530 acres of riparian area of objective 1 will be met (7.5 %) • 6 acres of the 70 acres of riparian area of objective 2 will be met (8.5%) • 1500 linear feet of the 9500 linear feet of objective 3 will be met (15.8%) This project in the Bear Creek sub-watershed is one of the last large projects we intend to do in Bear Creek due to the land owner constraints downstream. With the implementation of objectives 1, 2 and 3 we believe that achieving goals 2, 3, 4, and 5 can be done. Although there is recognition that there is lag time associated with nonpoint source-related projects and measured stream response, it is expected that this project will improve MIwb and IBI scores substantially at RM sites 6.32 and 6.5.
	Part 3: Load Reduced	Estimated 150.6lbs/yr. Total Nitrogen and 75.2 lbs/yr. Total Phosphorus and 32.4 tons/year sediment.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	Consulting firm will prepare the needed monitoring under 401 & 404 permits and 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.
criteria e	**Information and Education**	The project will be highlighted in the TCWP annual report and featured on the TCWP website and social media accounts. In addition information will be provided and education/outreach will comply with all grant and funding source requirements (e.g. 1 fact sheet and 1 press release).

Project #5 Summary Sheet

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Bedford Heights Stream & Floodplain Wetland Restoration at the Bus Garage
criteria d	**Project Lead Organization & Partners**	Tinker's Creek Watershed Partners City of Bedford Heights Environmental Design Group
criteria c	**HUC-12 and Critical Area**	04110002 05 04 Critical Area 1
criteria c	**Location of Project**	Bedford Transportation Department: 25441 Solon Rd, Bedford Heights, OH 44146 41.386421, -81.498720
n/a	**Which strategy is being addressed by this project?**	Urban Sediment and Nutrient Reducing Strategies Altered Stream and Habitat Restoration Strategies
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr.)
criteria	**Short Description**	Development causes bank erosion, habitat degradation, and excess sediment transport. When the stream floods properties, it carries oil/grease runoff from the bus garage. This project will restore stream functionality by installing flood control structures and a floodplain wetland.
criteria g	**Project Narrative**	This unnamed tributary to Tinker's Creek is located east of Interstate 271 and north of Solon Road. The project starts approximately 320 linear feet from the confluence of this tributary with Tinker's Creek and extends approximately 720 linear feet east along the existing stream channel. The Bedford Heights Waste Water Treatment Plant outfall discharges to this tributary just north of Solon Road. The tributary drains approximately 442.4 acres and has approximately 17.4% impervious surfaces. The steep, poorly vegetated streambanks present in this area send an excess amount of sediment into the system. This area has historically flooded the bus garage parking area, introducing additional sediment and vehicular debris into the stream channel. Both of these factors impact water quality and

		degrade aquatic life potential. The proposed project will restore 700 linear feet of entrenched stream and construct a ½ acre floodplain wetland. This project would also install in-stream rock structures to provide habitat and stabilize the stream channel. Four vortex rock weirs would be installed to improve in-stream habitat and maintain channel elevation. In the modified stream channel, 22 j-hook weirs would be installed. This channel would restore natural flow characteristics as the stream navigates the constraints of the bus garage parking, WWTP outfall, and topography to provide a stable corridor. While in-stream restoration techniques are proposed as rock vanes, toe rock, and rock J-hook weirs, ecological lift is a focus and these techniques could change in final design to maximize the ecological lift potential. Toe rock armoring with live whip plantings and erosion control matting anchored with live whips will stabilize and vegetate the streambanks and corridor while providing increased in-stream habitat. The existing concrete v-notch weir will be removed and replaced with a vortex rock weir, which will allow fish passage. Plantings include native trees and shrubs, live whips and perennials through seeding. This variety will provide a swift and diverse reestablishment of the riparian plant community while reducing sedimentation. The adjacent land use practices have affected the riparian buffers causing stream bank erosion, loss of vegetated habitat, and the propagation of invasive species. Invasive species eradication is proposed for 0.075 acres. This project would restore and stabilize the riparian buffer through removal of invasive species within the stream corridor, natural plantings, stream bank stabilization, and stream channel restoration using natural channel design techniques. This project will significantly reduce sediment and nutrient input into Tinker's Creek by installing a 0.5 acre floodplain wetland with a depth of 6 to 18 inches of permeant pool. Based on the U.S. EPA Region 5 model, the restoration will remove an estimated 170.6lbs/yr. of Total Nitrogen, 80.4 lbs/yr. of Total Phosphorus and 35.6 tons/year of sediment.

criteria d	**Estimated Total cost**	Sub-Contractual: Sub-Contractual costs were estimated by Environmental Design Group. Construction access is estimated to cost approximately $5,000.00; stream protection $16,300.00; stream bank restoration $80,700.00; floodplain wetland restoration $34,341.50; educational component $1,500.00; construction survey $4,000.00; engineering, survey, and permitting $16,840.98; non-construction allowances (permitting and environmental screening) $7,017.08; mobilization/demobilization $3,508.54; contingency (30%) $42,552.45; and insurance and bonds $2,105.12. **Total of $213,865.67 for the project**.
criteria d	**Possible Funding Source**	Section 319(h) grants, SWIF grants, Cuyahoga County GLRI-SWIF grants
criteria a	**Identified Causes and Sources**	Causes: direct habitat alterations, flow alterations Sources: land development, suburbanization
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	With the goals being to achieve an IBI score of at least 34 at Tinker's Creek near Bedford UPST Falls (RM 6.5) and at Tinker's Creek UPST Bedford Heights (RM 7.9) but currently only achieving scores of 28 and 20 respectively, the project will contribute to meeting this goal at RM 6.5 and 7.9. With the goals being to achieve an MIwb score of at least 7.4 at Tinker's Creek near Bedford UPST Falls (RM 6.5) and at Tinker's Creek UPST Bedford Heights (RM 7.9) but currently only achieving scores of 6.79 and 5.77 respectively, the project will contribute to meeting this goal at RM 6.5 and 7.9. Reasonable objectives for these goals are: **Objective 1:** Preserve and protect land along the riparian area of Tinker's Creek and its tributaries through acquisition and/or conservation easements. • Restore 530 acres of riparian area. **Objective 2**: Increase forest and understory cover of Tinker's Creek main stem and tributaries. • Plant 70 acres of riparian area. **Objective 3**: 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 9,500 linear feet of stream in Tinker's Creek.

	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	• 28 acres of 530 acres of riparian area of objective 1 will be met (5.3 %) • 8 acres of 70 acres of riparian area of objective 2 will be met (11.4 %) • 1500 linear feet of the 9500 linear feet of objective 3 will be met (15.8%) With the implementation of objectives 1, 2 and 3 we believe that achieving goals 4, 5, 6, and 7 can be done. Although there is recognition that there is lag time associated with nonpoint source-related projects and measured stream response, it is expected that this project will improve MIwb and IBI scores substantially at RM sites 6.5 and 7.9.
	Part 3: Load Reduced	Estimated 170.6lbs/yr. Total Nitrogen and 80.4 lbs/yr. Total Phosphorus and 35.6 tons/year sediment
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	Consulting firm will prepare the needed monitoring under 401 & 404 permits and 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
criteria e	**Information and Education**	At a minimum the project will be highlighted in the TCWP annual report and featured on the TCWP website and social media accounts. In addition information will be provided and education/outreach will comply with all grant and funding source requirements (e.g. 1 fact sheet and 1 press release).

Project #7 Summary Sheet

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	Glenwillow Stream & Floodplain Wetland Restoration
criteria d	**Project Lead Organization & Partners**	Tinker's Creek Watershed Partners Village of Glenwillow Environmental Design Group

criteria c	**HUC-12 and Critical Area**	04110002 05 04 Critical Area 1
criteria c	**Location of Project**	Nearby address: 7555 Bond Street, Solon, OH 44139 Site coordinates: 41.356175, -81.471923
n/a	**Which strategy is being addressed by this project?**	Urban Sediment and Nutrient Reduction Strategies Altered Stream and Habitat Restoration Strategies
criteria f	**Time Frame**	Short-Term (Priority) (1-3 yr.)
criteria	**Short Description**	Channelization, urbanization, and habitat degradation altered the ecological function of this stream, causing high temperatures and eutrophication. The four-phase project aims to provide ecological lift, increase habitat, and decrease erosion without undermining the nearby landfill.
criteria g	**Project Narrative**	Tinker's Creek south of Pettibone Road has been straightened to allow for the landfill, significantly impacting the natural flow regimes and ecological habitat. Straightening and channelizing the stream eliminated the dynamic scour and deposition of sediment. Invasive plant species thrive throughout this stretch of stream. The lack of trees and native vegetation throughout this portion of the stream causes higher temperatures, impairing native aquatic life and encouraging algae growth. This project will restore this channelized segment by creating a two-staged channel. More natural stream morphology will be created by increasing stream velocities, sinuosity, and water depth while reducing water temperatures and sediment transport without compromising the channel's ability to convey larger wet-weather flows. While in-stream restoration techniques are proposed as rock vanes, toe rock, and rock J-hook weirs, ecological lift is a focus and these techniques could change in final design to maximize the ecological lift potential. Due to the project's potential costs, it is recommended work be performed in four phases identified on the conceptual plan. In total, these phases include the creation of 1411 linear feet of pool, 1179 linear feet of run, and 489 linear feet of riffle. Floodplain storage will be increased by a total of 2.77 acres. A total of nine j-hook weirs will be installed in the pool area, and a total of four vortex rock weirs will be installed between the pool and run. During phase one, four fish boxes will be installed. A total of 9.2 acres of tree plantings and invasive species eradication are proposed for both sides of the bank. Work on the landfill side will require special design

		consideration for potential impacts to the closed landfill. The adjacent land use practices have encroached into the riparian buffers causing stream bank erosion, loss of vegetated habitat, and propagation of invasive species. This project proposes to eradicate 8.5 acres of invasive species along this portion of Tinker's Creek and revegetate with native perennials, shrubs, and trees to help support a highly functional riparian area and provide shading for the stream. Water quality improvements for this project include increased sediment deposition with the proposed floodplain expansions; reduction of sediment entering Tinker's Creek from denuded banks; treatment of storm water runoff from municipal landfill and residential development, and decrease in water velocities downstream due to increased flood storage. Improvements will also raise QHEI scores through in-stream habitat, stream shading, invasive species eradication, providing secure undercut banks through the use of fish shelves, increasing riparian width, and increasing stream morphology. Based on the U.S. EPA Region 5 model, this project will remove an estimated 198.3lbs/yr. Total Nitrogen, 100.2lbs/yr. Total Phosphorus and 56.6 tons/year sediment.
criteria d	**Estimated Total cost**	Sub-Contractual: Sub-Contractual costs were estimated by Environmental Design Group. Construction access is estimated to cost approximately $15,200.00; stream protection $84,473.33; stream bank restoration $909,440.31; floodplain expansion $125,077.78; construction survey $4,000.00; engineering, survey, and permitting $202,622.73; mobilization/demobilization $25,327.84; contingency (30%) $303,934.09; and insurance and bonds $15,196.70. **Total Cost for project: $1,560,195.02 for all four phases.**
criteria d	**Possible Funding Source**	Section 319(h) grants, GLRI grants, USFWS grants
criteria a	**Identified Causes and Sources**	*Causes of impairment:* • *Nutrients* • *Direct habitat alterations* • *Siltation* • *Flow alteration* *Sources of impairment:* • *Streambank modification* • *Land development/suburbanization* • *Urban runoff/stormwater* • *Removal of riparian vegetation*

criteria *b & h*	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	With the goals being to achieve an IBI score of at least 34 at Tinker's Creek UPST Bedford Heights (RM 7.9) but currently only achieving scores of 20, the project will contribute to meeting this goal at RM 7.9. With the goals being to achieve a MIwb score of at least 7.4 at Tinker's Creek Bedford Heights (RM 7.9) but currently only achieving scores of 5.77, the project will contribute to meeting this goal at RM 7.9. Reasonable objectives for these goals are: **Objective 1:** Preserve and protect land along the riparian area of Tinker's Creek and its tributaries through acquisition and/or conservation easements. • Restore 530 acres of riparian area. **Objective 2**: Increase forest and understory cover of Tinker's Creek main stem and tributaries. • Plant 70 acres of riparian area. **Objective 3**: 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 9,500 linear feet of stream in Tinker's Creek.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	• 60 acres of 530 acres of riparian area of objective 1 will be met (11.3%) • 8 acres of 70 acres of riparian area of objective 2 will be met (11.4%) • 1500 linear feet of the 9500 linear feet of objective 3 will be met (15.8%) With the implementation of objectives 1, 2 and 3 we believe that achieving goals 6, and 7 can be done. Although there is recognition that there is lag time associated with nonpoint source-related projects and measured stream response, it is expected that this project will improve MIwb and IBI scores substantially at RM 7.9.
	Part 3: Load Reductions	Estimated 198.3lbs/yr. Total Nitrogen and 100.2lbs/yr. Total Phosphorus and 56.6 tons/year sediment
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	Consulting firm will prepare the needed monitoring under 401 & 404 permits and 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.
criteria	**Information and**	At a minimum the project will be highlighted in the TCWP annual report and featured on the TCWP website and social media accounts. In addition

e	**Education**	information will be provided and education/outreach will comply with all grant and funding source requirements (e.g. 1 fact sheet and 1 press release).

Project # 9 Summary Sheet

Nine Element Criteria	Information Needed	Explanation
n/a	**Title**	Astorhurst Land Acquisition and Stream Restoration
criteria d	**Project Lead Organization and Partners**	Cleveland Metroparks
criteria c	**HUC-12 & Critical Area**	04110002 05 04 Critical Area 1
criteria c	**Project Location**	7000 Dunham Rd, Walton Hills, OH 44146 41.372052, -81.579956
n/a	**Which strategy is being addressed by this project?**	Urban Sediment and Nutrient Reduction Strategies Altered Stream and Habitat Restoration Strategies
criteria f	**Time Frame**	This site acquisition will be completed in 2018 followed by the restoration concept and continued restoration efforts focusing on stream day lighting, floodplain reconnection and terrestrial and aquatic habitat restoration. We have all the property owners lined up and all the initial conceptual design work being completed in 2017. This will be a short term project 1-3 years.
criteria g	**Short Description**	Acquisition of this property will protect a portion of Tinker's Creek and its associated headwater streams while helping to remove impairments to the watershed, like excess nutrients and loss of habitat, through the removal of existing buildings and stream/floodplain restoration. This property is a very high conservation priority area and the habitat restoration area.
criteria g	**Project Narrative**	The Astorhurst Land Company Property (Astorhurst Property) is located on Dunham Road just south of Tinker's Creek Road in the Village of Walton Hills near the Valley View border and adjacent to Cleveland Metroparks Bedford Reservation and Cuyahoga Valley National Park. This 127 acre property has been operating as a golf course under the name of Astorhurst Country Club since 1968. The Astorhurst Property is a regionally unique property as properties of this size and quality are extremely rare in Cuyahoga County. Protection of the Astorhurst property would preserve a portion of Tinker's Creek and its associated headwater streams and floodplains. Tinker's Creek is the largest tributary to the Cuyahoga River, stretching 30 miles and collecting water from 96.4 square miles in 24 communities. Major issues impacting Tinker's Creek are excess nutrients, loss of wetlands, stream bank erosion and loss of habitat. Preservation

		and restoration of the Astorhurst Property will help in meeting water quality improvements the overall health of the Tinker's Creek watershed. The 2016 Cleveland Metroparks Bedford Reservation Master Plan identified this area for protection and specifically spoke to restoring and enhancing Tinker's Creek and its associated floodplain connections. The Bedford Reservation Master Plan intends to remove the existing buildings. Additionally, the floodplain and creek connections will be restored and enhanced to help reduce impairments to the watershed. Finally, all-purpose trail connections and trailhead amenities will be installed at this location.
criteria d	**Estimated Total Cost**	Sub-contractual: Construction costs assume that no hazardous waste will be identified during the design phase and that hazardous material will not need to be removed during construction. They also assume that soil amendments and the removal of unsuitable material (such as concrete debris) will be minimal and that utility repair or relocation is unnecessary. The concept-level opinion of probable cost for final design, permitting, and construction is shown below: - Land acquisition - $3.1 million - Final Design and Permitting - $100,000 - Construction Administration (including planning and administration) - $180,000 - Mobilization, Site Preparation, and ESC - $95,000 - Grading, Structures, and Site Stabilization - $480,000 - Planting - $180,000 - Post - Construction Monitoring (3 years) - $15,000 - Contingency (30%) – $450,000 - **Total Construction Costs: $4,600,000**
criteria d	**Possible Funding Source**	Clean Ohio Fund, Section 319(h), USFWS and GLRI
criteria a	**Identified Causes and Sources**	Causes of impairment: • Nutrients • Direct habitat alterations • Siltation • Flow alteration Sources of impairment: • Streambank modification • Land development/suburbanization • Urban runoff/stormwater • Removal of riparian vegetation

criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment associated with this Critical Area?**	With the goal being to maintain the IBI score of at least 34 at Tinker's Creek near Walton Hills at Dunham Road (RM 2.18), site currently has a IBI score of 38, and maintain an MIwb score of 7.4, currently the score is 7.68. Reasonable objectives are: **Objective 1**: Preserve and protect land along the riparian area of Tinker's Creek and its tributaries through acquisition and/or conservation easements. • Restore 530 acres of riparian area. **Objective 3:** 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 9,500 linear feet of stream in Tinker's Creek.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	• 127 acres of 530 acres of riparian area of objective 1 will be met (24 %) • 3,000 linear feet of the 7,500 linear feet of objective 3 will be met (40%) This project in the Tinker's Creek watershed is one of the large projects we are working on at the moment. Due to the fact that the confluence with the Cuyahoga River is just downstream this will be a great project to complete. With the implementation of objectives 1 and 3 we believe that the project will achieve goals 14, and 15.
	Part 3: Load reduced?	Estimated 160.6 lbs/yr. Total Nitrogen and 85.2 lbs/yr. Total Phosphorus and 35.7 tons/year sediment.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	Cleveland Metroparks will prepare the needed monitoring under 401 & 404 permits and if the project is funded through the Ohio EPA Section 319(h) program, staff from the OEPA-DSW Ecological Assessment Unit will perform both pre- and post-project monitoring.
criteria e	**Information and Education**	The project will be highlighted in the Cleveland Metroparks annual report and featured on the Cleveland Metroparks website and social media accounts. In addition information will be provided and education/outreach will comply with all grant and funding source requirements (e.g. 1 fact sheet and 1 press release).

Works Cited

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354

Appendix A: Acronyms and Abbreviations

A

ALU Aquatic Life Use

AoC	Area of Concern
B	
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