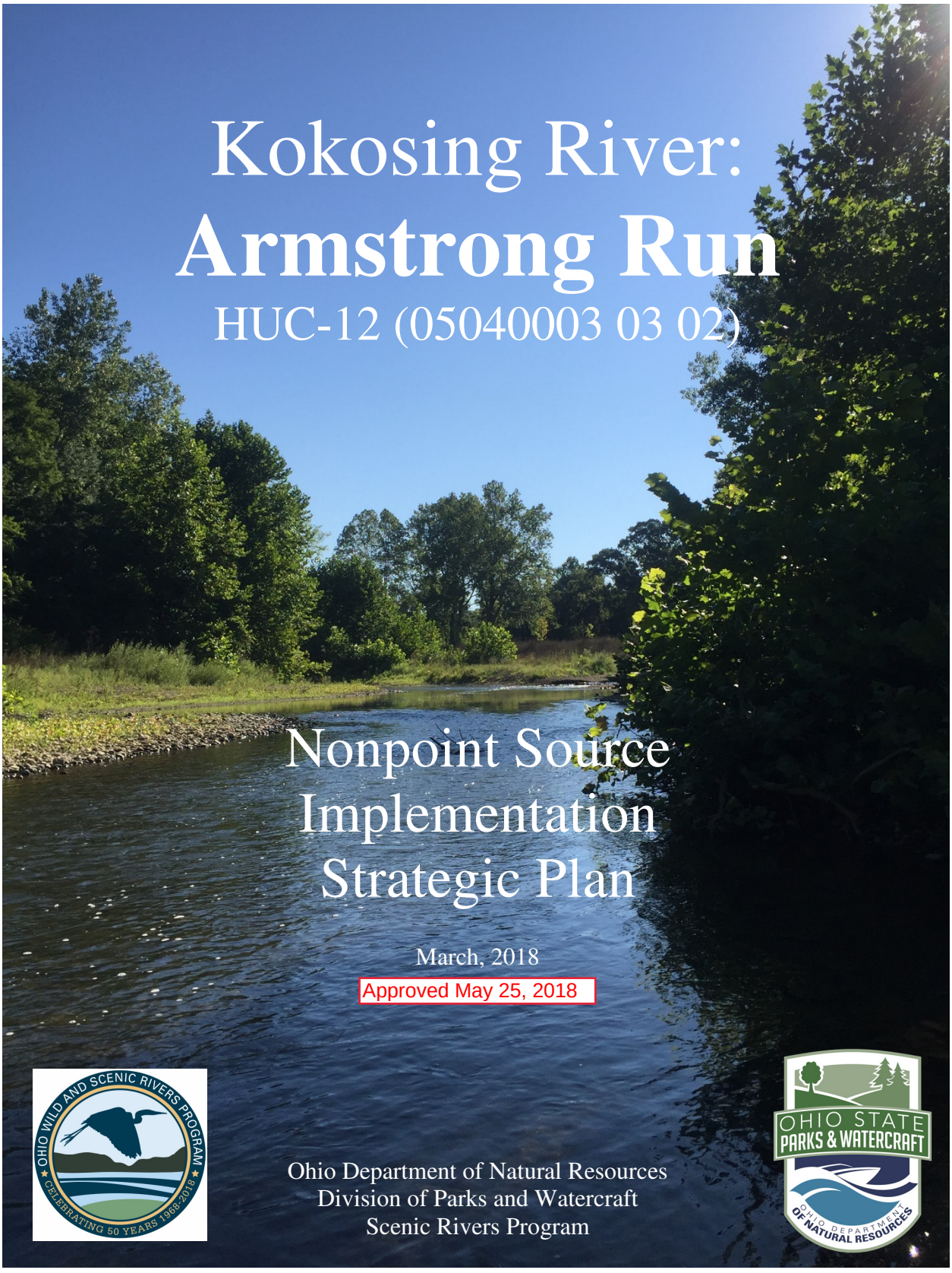

Kokosing River:
Armstrong Run
HUC-12 (05040003 03 02)

Nonpoint Source Implementation Strategic Plan

March, 2018

Approved May 25, 2018

Ohio Department of Natural Resources
Division of Parks and Watercraft
Scenic Rivers Program

This document was created by the Ohio Department of Natural Resources Division of Parks and Watercraft's Scenic Rivers Program. The program is located at 2045 Morse Road, Building C-4, Columbus, OH 43229-6693. Visit http://watercraft.ohiodnr.gov/scenicrivers for additional information.

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Acknowledgements

Thank you to Mount Vernon City Engineer Brian Ball for sharing his knowledge of river geomorphology and assistance in developing projects to improve the health of the Kokosing River, and to Heidi Hetzel-Evans for editorial guidance.

Chapter 1: Introduction

1.1 Report Background

The Armstrong Run 12-digit Hydrological Unit Code (05040003 03 02)[1] subwatershed is located near the middle of the Kokosing River watershed in Knox County, Ohio. It is named for its largest tributary (Armstrong Run), and also includes portions of the mainstem of the Kokosing River and additional smaller tributaries. Much of the land use within the subwatershed is agricultural, while the eastern portion encompasses suburban and urban land uses, including downtown Mount Vernon. A narrow wooded riparian corridor has been maintained along portions of the mainstem of the Kokosing River on private and public land, though farms, former quarries and industrial sites are also found on its banks.

The Kokosing River is among a select group of the state's best remaining rivers. It was designated as a state scenic river by the Ohio Department of Natural Resources (ODNR) Scenic Rivers Program in 1997. It supports rich biodiversity and recreational uses, plus a close association with ground water that serves as drinking water for many Knox County residents. The river and many tributaries have been classified by the Ohio Environmental Protection Agency (EPA) as exceptional warmwater habitat (EWH), which is the agency's highest aquatic life use level.

In cooperation with watershed partners, ODNR Scenic River Program staff developed a comprehensive Kokosing River watershed plan in 2004. It referenced a 1987 Ohio EPA biological and water quality study that found a majority of the river's sampling sites to be in attainment of aquatic life uses. A small proportion of river segments were identified as impaired due to agriculture, waste water treatment plants and urban runoff. The steering committee, comprised of 20 members with wide-ranging watershed interests, identified cattle exclusion fencing as a cost-effective means to solve multiple issues, and ODNR received an Ohio EPA Section 319 nonpoint source pollution grant to implement that strategy.

This plan updates a portion of the 2004 plan for the Armstrong Run HUC-12, and was completed in close partnership with the City of Mount Vernon. The extensive background information provided in the 2004 plan is referenced frequently in this update, though revisions and additions have been included where new information has become available or circumstances have changed. This update also focuses on a legacy of industrial land use and habitat alterations in the Armstrong Run HUC-12 not addressed in the 2004 plan. New data is presented here to quantify these threats to the Kokosing River's high quality. ODNR anticipates continued collaboration with watershed partners to develop future projects in additional HUC-12 subwatersheds.

[1] The United State Geological Survey has established Hydrologic Unit Codes, of HUCs, as a numeric system for identifying watersheds. The first two digits for the Armstrong Run subwatershed are "05", indicating that it is in the Ohio River basin. Additional digits specify smaller subwatersheds within the larger basin. The 12-digit Hydrologic Unit Code, or "HUC-12", is the system's most detailed code, identifying the smallest subwatershed.

1.2 Watershed Profile and History

The majority of the 57-mile-long Kokosing River and its 482 square mile watershed falls within rural Knox County, Ohio, which is located in north central Ohio. Small portions also lie within Ashland, Coshocton, Morrow and Richland counties (Figure 1). The Armstrong Run HUC-12 falls near the center of the Kokosing River watershed and contains a portion of its largest population center, the City of Mount Vernon, with 16,000 residents (Figure 2). Upstream, the North Branch of the Kokosing River flows through Fredericktown, while downstream the river flows east through the villages of Gambier and Howard. It joins the Mohican River at its terminus to become the Walhonding River, which flows south and east into the Muskingum and Ohio rivers.

The HUC-12 includes 3.4 river miles of the Kokosing River mainstem. It begins at river mile (RM) 29.6, west of State Route 13 between Mount Vernon and Fredericktown and downstream of its confluence with a major tributary, the North Branch (classified EWH). The river flows south towards RM 28.6 (Banning Road), the location of the Ohio EPA's one sample site for the Kokosing River mainstem in the HUC-12. At this point, the Kokosing River watershed drains 200 square miles. The HUC-12 terminates at RM 26.1, just downstream of Main Street in Mount Vernon and upstream of the Dry Creek tributary confluence. Armstrong Run, the tributary for which the HUC-12 is named, is 5.9 miles long, has an average fall rate of 43.1 feet per mile, and drains a 17-square-mile watershed. It flows into the Kokosing River from the west at approximately RM 28.0.

The HUC-12 occurs in an area that was once deeply forested and features gently rolling hills. The first European settlers began arriving in the late 1700s. Ohio reached statehood in 1803, and Mount Vernon was settled in 1805. Some of the region's industrial roots are tied to its location on the Ohio glaciation boundary. As glaciers receded northward, meltwater laden with boulders, sand and gravel cut the path of modern rivers and deposited this material in their floodplains. Access to this sand and a well-connected rail system gave rise to a local glass-making industry. Sand and gravel are still mined from the river's floodplain, and the legacy of mining is a focal point of this plan.

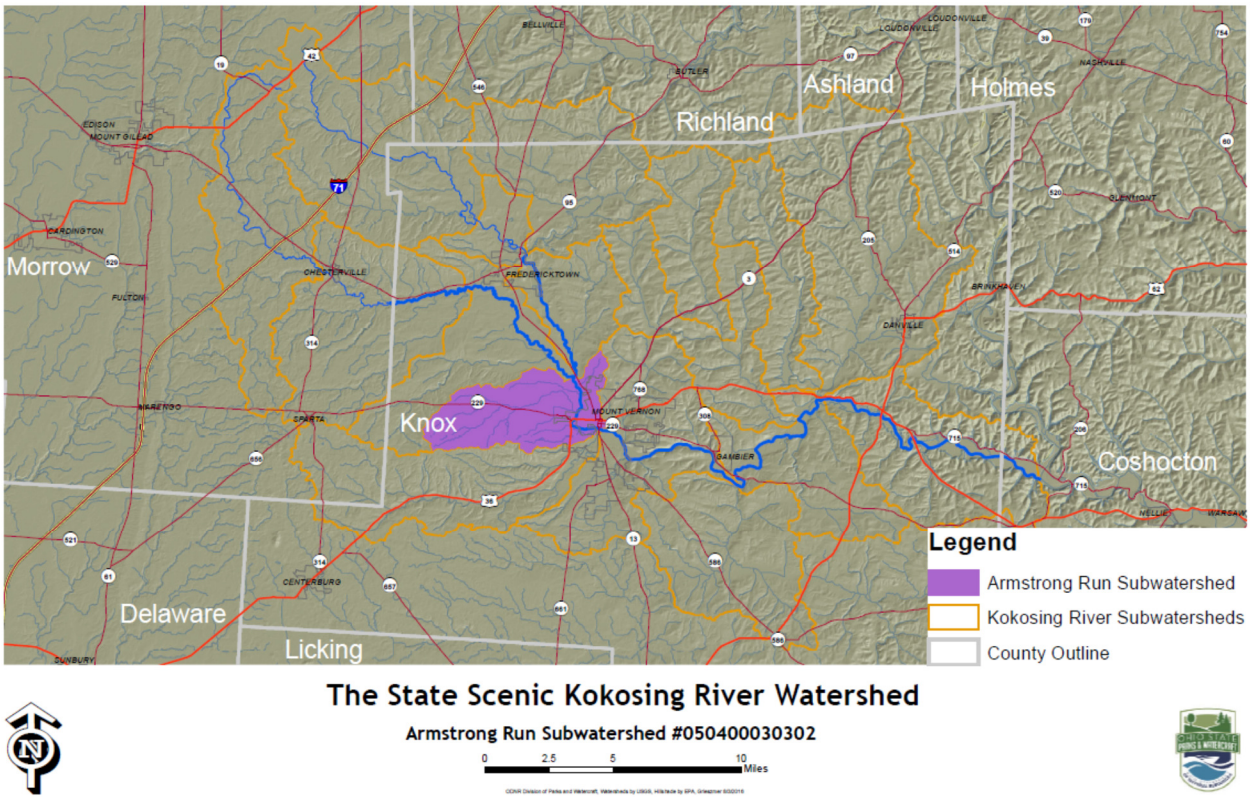

Figure 1

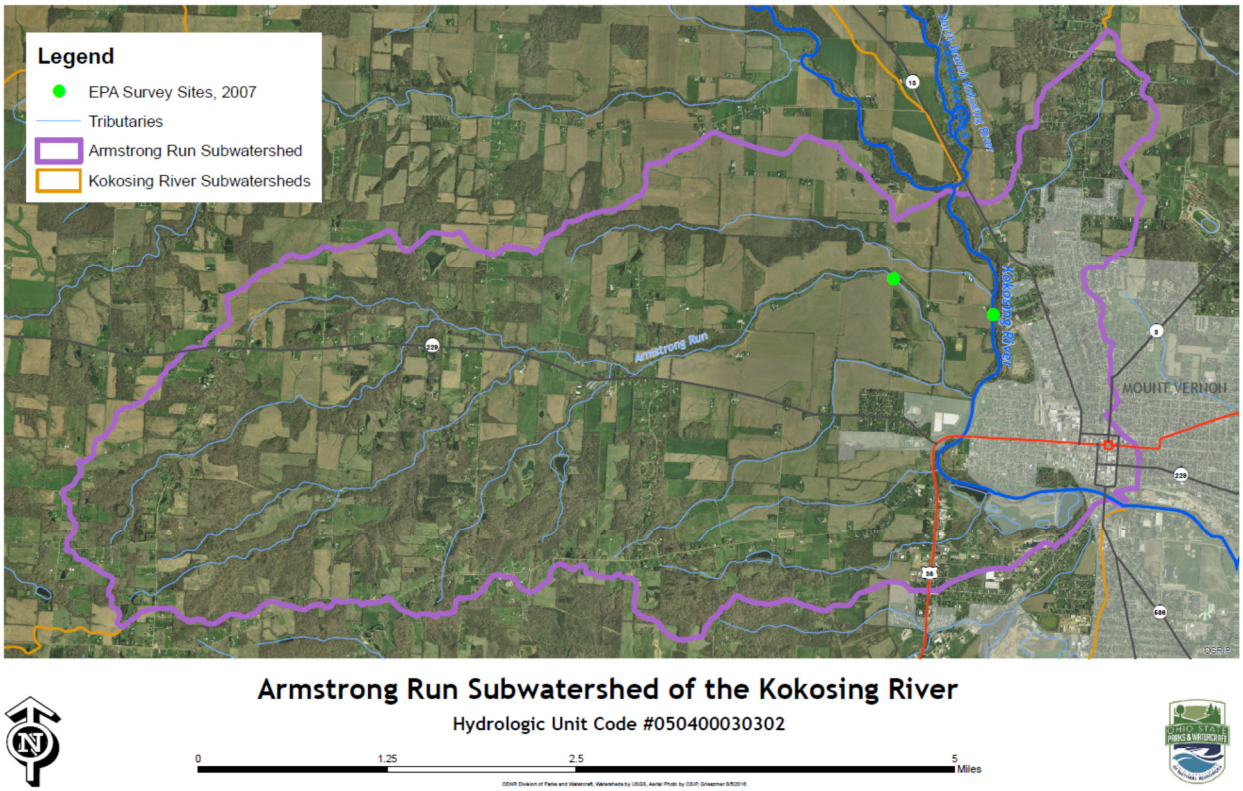

Figure 2

1.3 Public Participation and Involvement

ODNR convened a 20-member steering committee to complete the 2004 Kokosing River watershed plan. A committee was not used for this plan update, in part because the geographic focus is much smaller. Scenic Rivers Program staff worked closely with the largest stakeholder in the Armstrong Run HUC-12, the City of Mount Vernon, including site visits, canoe floats and implementation strategy development. Staff continue to work collaboratively with former steering committee member organizations through events, such as an annual river cleanup, and through the Kokosing State Scenic River Advisory Council. These venues provides opportunities to share updates, gather feedback and discuss opportunities for additional future projects.

Chapter 2: Armstrong Run HUC-12 Watershed Characterization and Assessment Summary

2.1 SUMMARY OF ARMSTRONG RUN HUC-12 WATERSHED CHARACTERIZATION

2.1.1 Physical and Natural Features

Ecoregion and Geology

Knox County is located at the edge of glaciated Ohio. It was inundated almost completely by the Illinoan glaciation, followed by the Wisconsian glaciation which covered approximately half of the county. As glaciers receded northward, meltwater laden with boulders, sand and gravel cut the path of modern rivers and deposited material in their floodplains. The watershed is generally dominated by glacial till deposits over sedimentary sandstone bedrock. Along the floodplains of Armstrong Run and the Kokosing River, alluvium soil formed in recent stream deposits consists mainly of well-drained Tioga fine sandy loam. For more detail on soils, see the 2004 Kokosing River watershed plan.

The Ohio EPA Kokosing River Biological and Water Quality Study of 2007 (published in 2010) includes a good overview of Kokosing watershed topography: "The Kokosing watershed drains the Low Lime Drift Plain of the Erie-Ontario Lake Plain ecoregion. The topography is characterized as 'rolling' with scattered end moraines and kettles. Typically, soil series found in this ecoregion are less fertile than the higher lime till plains of the Eastern Corn Belt ecoregion seen to the west" (p. 20). It also describe that "beech-sugar maple forest type predominates grading into other community types such as oak-hickory, mixed mesophytic, and maple-cottonwood-sycamore" (p. 29).

Thick, permeable sand and gravel glacial deposits comprise the highly productive Kokosing Buried Valley Aquifer which was carved into shale and sandstone bedrock and parallels the Kokosing River. It is the source of Mount Vernon's public drinking water supply, which serves more than 25,000 people. On average, 2.5 million gallons of water per day are produced from two wells located on either side of the Kokosing River near Riverside Park (just north of State Route 36). In its 2012 Source Water Assessment and Protection Plan update, the city recognized vulnerabilities such as the aquifer's relatively shallow depth and discontinuous overlying protective layer of clay. The plan outlines a source water protection zone, defined as the five-year water travel time within the aquifer, which extends northwest from Mount Vernon following the Kokosing River valley and buried aquifer.

Wetlands

The U.S. Fish and Wildlife Service National Wetland Inventory online map tool (www.fws.gov/ wetlands/data/mapper.html accessed September 26, 2016) indicates a few

notable forest/shrub wetland complexes in the subwatershed north of Banning Road and west of Upper Green Valley Road. A complex bordering Armstrong Run measures approximately 7 acres; an additional complex measuring about 58 acres is found north of Armstrong Run on an unnamed tributary that flows into the Kokosing River at approximately RM 28.75. Another 7-acre wetland is located on an Armstrong Run headwater tributary west of Blue Road and north of New Delaware Road. For additional background on wetlands throughout the Kokosing River watershed, see the 2004 watershed plan.

Rare, Threatened and Endangered Species

Bald Eagle - In 1979 only four nesting pairs of bald eagles existed within the state of Ohio due to the widespread use of the pesticide DDT, which contaminated their food sources. Conservation efforts included federally listing the bird as endangered in 1976 and banning DDT in 1979. The population has since recovered and was federally delisted in 2007. According to the ODNR Ohio Division of Wildlife (ODOW), Ohio boasted 207 breeding pairs and 288 young in 2015. The bald eagle is no longer a state-listed species.

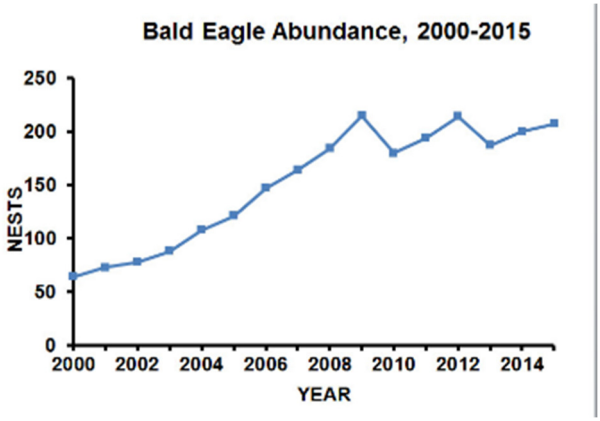

Figure 3

Graph courtesy of http://wildlife.ohiodnr.gov/species-and-habitats/species-guide-index/birds/bald-eagle

The Kokosing River valley provides suitable habitat for bald eagle nesting as well as for foraging and hunting of fish, waterfowl and small mammals. According to long-time volunteer bald eagle monitor Jon Minard, 10 nesting pairs are known in Knox County (J.Minard, personal communication, 2016). Although no nests occur in the Armstrong Run HUC-12, bald eagles are frequently seen flying in the river corridor.

Osprey – Osprey were extirpated from Ohio in 1913. One breeding pair returned naturally to the state in 1995, followed by restoration efforts in 1996. In the 2015 Wildlife Plan, ODOW reported that 180 chicks fledged from 105 osprey nests in 2012 (p. 30). According to Dr. Raymond Heithaus, two osprey nests were found in northwestern Knox County during the 2006-2011 Breeding Bird Survey (personal communication, 2016). Osprey are regularly sighted in downstream reaches of the river, including Mount Vernon (within the Armstrong Run HUC-12) and Gambier, suggesting that there may now be additional nests.

Hellbender – The hellbender salamander is an Ohio endangered species and a federal species of concern. Anecdotally, it once thrived in the Kokosing River watershed but is now quite rare and may no longer maintain a viable breeding population. One individual was found at Schenck Creek in the 2007 Ohio EPA survey, and two additional verified sightings occurred in the Kokosing mainstem in 2007 and 2008 near Gambier and Howard (Gregg

Lipps, personal communication, April 2, 2016). In response, the ODOW, Columbus Zoo & Aquarium, The Ohio State University and other partners released approximately 130 juvenile, captive bred hellbenders into the Kokosing River downstream of the Armstrong Run HUC-12 in 2016. The partners plan to release more juveniles in future years.

River Otter – According to ODOW, the river otter was extirpated from Ohio in the early 1900s and reintroduced in 1986. It was removed from Ohio's endangered species list in 2002 and had expanded its population to approximately 8,000 individuals by 2012. The 2004 watershed plan notes an unconfirmed report of river otter in Mount Vernon in 2002. River otters are now thought to be present in the Kokosing River watershed in small numbers, while neighboring watersheds to the north and east host medium-sized populations (p. 44).

Blue Breast Darter - The 2010 Ohio EPA Kokosing River Report noted a very strong population of the blue breast darter in the Kokosing River, which at the time was an Ohio threatened species. Given a resurgence in its population in recent years, the species was removed from the list in 2012.

Spotted Darter - The spotted darter is a state endangered species and was documented in the Kokosing River at RM 2.7 in the 2010 Ohio EPA report.

2.1.2 Land Use and Protection

The majority of the Armstrong Run subwatershed's 17 square miles (or 10,880 acres) occur to the west of the Kokosing River mainstem and are rural. The area is characterized by woodlands, farms and some 1 or 2-acre residential lots. Knox County townships within the watershed include Clinton, Liberty, Morris and Wayne. Land use to the east and south of the mainstem is suburban transitioning to urban in downtown Mount Vernon. Current and historic industrial land uses also dot the river banks, most notably on the south side of the river. A summary of 2011 land use data is shown in Table 1.

Land use trends

Although agriculture is the dominant land use in the watershed, residential land use is becoming increasingly significant in unincorporated areas of the Kokosing River watershed. The following is an excerpt from the Knox County Comprehensive Plan, 2012 update (p.17):

> "Figure [4] shows the population and projected population for Knox County and surrounding counties from 1980 through 2030. This figure shows relatively steady growth for Knox and Ashland Counties over the period. That steady growth is in sharp contrast to the rapid growth in neighboring Delaware and Licking counties. Coshocton, Morrow and Richland remain little changed. The county grew by 28.3% between 1990 and 2010 while the State of Ohio grew by 6.4%. The Ohio Office of Strategic Research has predicted that the population of Knox County will grow 8.2% from its 2010 population of 60,921 by 2020 while Ohio grows 4.1%. Clearly, much of the growth in

Knox County is related to expanding opportunities for employment in the Columbus/Franklin County area."

Land Use Type	Square Miles	% of watershed	Land Use Type	Square Miles	% of watershed
Barren Land	0	0	Evergreen Forest	0.08	0.48%
Cultivated Crops	5.02	29.45%	Hay/Pasture	2.93	17.21%
Deciduous Forest	5.81	34.10%	Herbaceous	0.16	0.92%
Developed, High Intensity	0.26	1.51%	Mixed Forest	0.00	0.01%
Developed, Low Intensity	0.91	5.34%	Open Water	0.16	0.96%
Developed, Medium Intensity	0.34	1.98%	Shrub/Scrub	0.05	0.28%
Developed, Open Space	1.30	7.60%	Woody Wetlands	0.02	0.14%
Emergent Herbaceous Wetlands	0.01	0.03%	**Total square miles**	**17.05**	

Table 1: 2011 land use data for the Armstrong Run HUC-12 watershed.

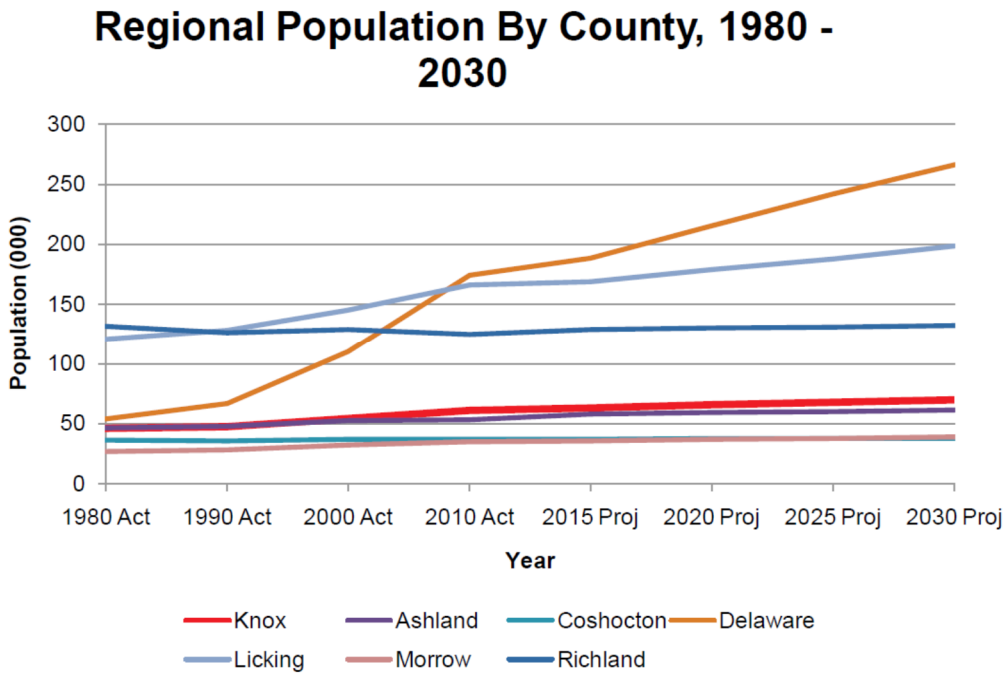

Figure 4: Regional Population by County, 1980-2030: Knox County Comprehensive Plan 2012 Update.

According to the Knox County Comprehensive Plan 2012 update, "The Kokosing and Mohican rivers are important economic, scenic, historic and environmental assets to Knox County." The plan lists many conservation-oriented recommendations (p. 56):

- sound floodplain management as green infrastructure to prevent encroachment of structures and reduce costs associated with flooding;
- implementation of the 2004 Kokosing Watershed Management Plan;
- protection of well fields and aquifer recharge areas from inappropriate surface land uses; and
- ongoing design measures for site plan and subdivision regulations to meet standards for avoiding pollution of storm water and ground water.

The 2010 Ohio EPA Kokosing River report summarizes land use policy for the City of Mount Vernon. At the time, the city had a zoning code and subdivision regulations but did not have a comprehensive plan. Although no ordinances contain specific standards for protecting streams and riparian buffers, it was noted that these are important community assets and should be protected within subdivisions. Within the subdivision regulations, there were some limited protections for watercourses and floodplains, as well as larger trees and woodlots through the city's Tree Preservation Ordinance (p. 40). The city has also recently completed a comprehensive digital tree inventory to better track maintenance needs and opportunities for improving canopy cover (B. Ball, personal communication, June 20, 2016).

Riparian Corridor and Public Lands

The 2010 Ohio EPA report noted a generally intact forested riparian corridor for the Kokosing River mainstem; the amount forested to at least 100 feet was 56.1% of the length of both banks. However, the authors described the riparian forests through Mount Vernon (from RM 25 to RM 29) as "minimal to nonexistent," containing the least amount in the Kokosing watershed (p. 27). Figure 2 shows a relatively thin corridor that is nearly absent in a few locations. The northern (or left descending) river bank upstream of Main Street, for instance, is very steep, eroding and unable to maintain vegetation beyond grass and opportunistic weeds. Phillips Drive is located at the top of the slope, leaving space for only a few landscaping trees between the river and the streets of downtown Mount Vernon (Figure 22).

Forest depth does expand more than 500 feet on city-owned land west and south of Arch Avenue and on some private parcels. Regardless of depth, the benefit of a wooded corridor is limited by an extensive levee system in Mount Vernon. Levees vary in proximity to the river, sometimes occurring directly on the river bank and at other times further away. See details about the levee system in chapters 2.3 and 3.2.1.

The city owns a significant portion of riparian frontage along the Kokosing River in the subwatershed, especially downstream of the American National Can site (Figure 5 and Figure 6). Public parks found here include Riverside Park (east of the river along the left descending bank north of State Route 36), Arch Park (north of the river along the left descending bank on Arch Avenue) and Aerial-Foundation Park (south of the river on the right descending bank west of Main Street). Aerial-Foundation Park encompasses a former industrial site and three former quarries adjacent to the river, and is the site of proposed

projects detailed in chapter four. ODNR Scenic River Program also owns a 21.22 acre easement within the park in the project area.

The riparian corridor of Armstrong Run is 62.7% forested. The majority of the wooded riparian corridor occurs in the upper half of its length, where topography is more rolling and row-crop agriculture is intermittent.

Commercial / Industrial

Two auto salvage yards are located on the east bank of the river in the subwatershed on either side of the 45-acre American National Can factory site. According to the Ohio EPA, Division of Emergency and Remedial Response, the site was occupied from 1926 until 1999 when the buildings were razed (Ohio EPA DERR, 2009, p. 3). Soil and groundwater contaminants found on site included metals, volatile organic chemicals and semi-volatile organic chemicals. In addition, downstream Kokosing River sediments are contaminated by fluroanthene, pyrene and lead above the U.S. EPA Region 5 Resource Conservation and Recovery Act ecological screening levels. Utilizing grant funds, the City of Mount Vernon is near completion of a site cleanup (excluding river sediment) and anticipates redevelopment.

On the south bank of the Kokosing River upstream of Main Street lies the largest former industrial site in the subwatershed and possibly the entire Kokosing River watershed. Here, former gravel quarries and ruins of Pittsburgh Plate Glass Company (PPG) factory buildings have been converted into the 200-acre Ariel-Foundation Park. The glass-making industry employed 1,000 people in Mount Vernon at its peak in the 1950s; the PPG factory operated until 1979. Gravel quarries associated with this site are now recreational lakes with narrow levees separating them from the river. A breach occurred in one of these levees in December, 2017. In-stream gravel mining also resulted in direct excavation of more than 2,400 linear feet of stream bank and riparian corridor. This area is described in detail in chapter three and is the focal point of proposed projects outlined in chapter four.

The majority of the Mount Vernon downtown commercial and retail district falls within the Armstrong Run HUC-12, extending north from the river along Main Street. This area's connection to the river and Ariel-Foundation Park has recently been enhanced by a bike trail extension spanning the river and Main Street, connecting the renovated CA&C Depot to downtown using a pre-existing railway trestle. Plans also exist to connect the trail under the Main Street bridge. This connection unites two segments of trail – the Kokosing Gap Trail and the Heart of Ohio Trail – which will become portions of the Ohio to Erie Trail extending from Cleveland to Cincinnati.

The anticipated increase in trail use presents tremendous opportunity for economic growth in Mount Vernon and expanded recreational use of the Kokosing River by land and water. The proposed restoration projects outlined in chapter four will further enhance the aesthetic, ecological, and navigational qualities of the river at this nexus.

Additionally, the city has pursued two innovative and educational stormwater projects in this corridor. With assistance from ODNR, the city received an Ohio EPA Surface Water Improvement Fund grant to create a bioswale and rain garden demonstration project at the

CA&C Depot, which has been renovated as a trail way-station. The city is also seeking funds to retrofit Blackberry Alley (east of Main Street and north of the river) into a bike and pedestrian way that will connect to the bike path. Stormwater from rooftops and roads in this highly impervious area currently receives no treatment before discharging to the river. This project will capture runoff from two city blocks and create retention structures underneath the alley.

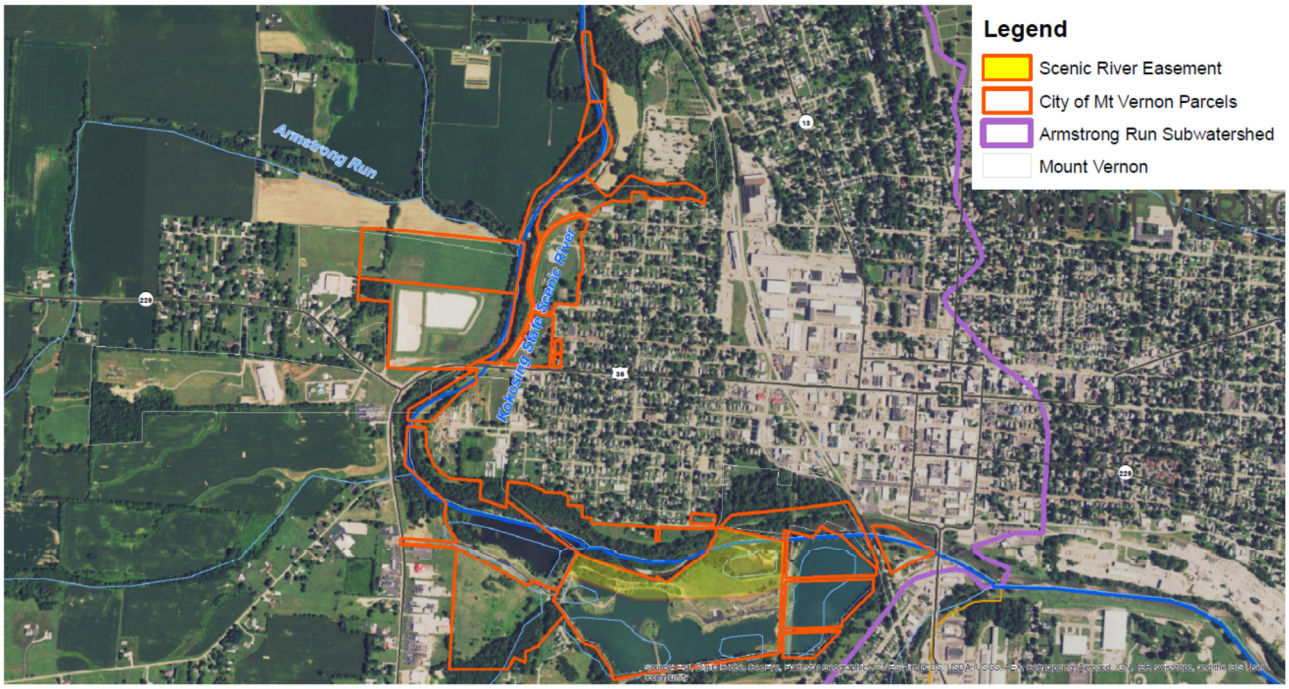

Figure 5

2.2 SUMMARY OF BIOLOGICAL TRENDS

The Ohio EPA conducted a biological and water quality study of the Kokosing River in 2007, which was published in 2010. Prior to then, 30 miles of the river (from the mouth to the confluence with North Branch) had been designated as exceptional warmwater habitat (EWH) aquatic life use. In its 2010 report, the Ohio EPA recommended that the remaining 27 miles of mainstem plus several tributaries be upgraded from warmwater habitat (WWH) to EWH. Several tributaries were also recommended as cold water habitat (CWH), capable of supporting rare, sensitive cold-water species. Armstrong Run was recommended for upgrade from WWH to EWH and CWH. Two fish species known to prefer cool streams fed by

groundwater, the redside dace and mottled sculpin, were found in Armstrong Run in the 2007 study.

The report found impairments in some segments of the Kokosing River watershed related to agriculture, waste water treatment plants (downstream of the Armstrong HUC-12 at RM 24.3) and urban runoff. Within the Armstrong Run HUC-12, the study included samples at Kokosing River RM 28.6 at Banning Road, and at Armstrong Run RM 1.1 at Lower Green Valley Road. Based on scores for fish species diversity and population health (IBI), fish abundance and biomass (MIwb), invertebrate communities (ICI), and habitat quality (QHEI), the study found both sites to be in full attainment of EWH (Table 2).

The Ohio EPA did note "nonsignificant departures" for a few scores that were at or just below the EWH use attainment threshold but too small of a deviation to deem the site in non-attainment. The EWH standard for IBI is 48, which is equal to the IBI scores reported at both sampling sites. A nonsignificant deviation was also noted for the 9.3 MIwb score at the Kokosing River site. The EWH standard is 9.6, while the WWH standard is 8.7.

Prior to 2010, the most recent Ohio EPA report was published in 1987. The 2010 study states that "comparisons for most parameters in the middle Kokosing River mainstem [between the two reports] showed strikingly similar results indicating little change in the chemical composition of the river over time" (p. 67). The 2010 study found a slight improvement in the ICI score at RM 28.6, which increased from 48 to 52.

Waterway	River Mile	IBI	MIwb	ICI	QHEI	Attainment status (EWH)
Armstrong Run	1.1	48 ^{ns}	NA	E*	71.5	Full
Kokosing River	28.6	48 ^{ns}	9.3^{ns}	52	82	Full

Table 2: Results from Ohio EPA Biological and Water Quality Study of the Kokosing River, 2007, for two sampling locations in the Armstrong Run HUC-12. E = exceptional; ns = non-significant departure

The Ohio EPA noted that Armstrong Run was influenced by inflow of a moderate amount of groundwater, which cooled water temperatures and helped maintain favorable dissolved oxygen levels and stream flow through dry summer months (p. 147). Based on "exceptional biota and very good chemical water quality" in Armstrong Run, the Ohio EPA proposed the upgrade in status from WWH to EWH. Armstrong Run was not included in the 1987 study.

The 2010 study did not survey downstream reaches of the mainstem for this HUC-12, leaving approximately two river miles without data. Additional QHEI data were collected by ODNR in August 2016, and are described in chapter 3.2.2.

2.3 SUMMARY OF NPS POLLUTION CAUSES AND ASSOCIATED SOURCES FOR ARMSTRONG RUN HUC-12

No causes and sources of impairment are identified in the Armstrong Run HUC-12 according to the Ohio EPA's 2010 Kokosing River water quality study, and accordingly, none are listed in the Ohio EPA's 303d list of impaired waters (Ohio EPA, 2016). Rather than reverse impairments, the overall goal of this plan is to protect this high quality waterway by addressing threats. The HUC-12 is threatened by habitat alterations that occurred downstream of the Ohio EPA sample point at Banning Road (RM 28.6) and the terminus of the subwatershed. Based on additional QHEI data collected by ODNR in August 2016, potential causes and sources of impairment that threaten the Kokosing's exceptional warmwater habitat aquatic life use are:

Rather than reverse impairments, the overall goal of this plan is to protect this high quality waterway by addressing threats.

Causes of Impairment	**Sources of Impairment**
Direct habitat alteration	In-stream and floodplain mining
Siltation	In-stream mining, levees
Channelization	Levees

Direct habitat alteration resulted from in-stream mining in the 1960s which removed approximately 2,400 linear feet of river bank and riparian corridor. The effects of mining are still present in the form of channel instability, excessive siltation (within a remaining open backwater area with thick silt deposits) and bank erosion.

Channelization of the river through an extensive levee system also contributes to siltation and reduced in-stream habitat development. During flood events, levees prevent the river from accessing its floodplain to dissipate the force of flood water or deposit sediment outside of the channel. The scouring effect of flood water prevents in-stream habitat (such as run-riffle-pool sequences) from developing.

Levees also present a long-term challenge because they narrowly separate the river from a series of quarry lakes, which were the result of gravel mining in the floodplain. A breach of one of these levees occurred in December, 2017 during a 10-year flood event, which further threatens the integrity of the river channel. Additional breaches continue to be a threat in this area.

2.4 ADDITIONAL INFORMATION FOR DETERMINING CRITICAL AREAS AND DEVELOPING STRATEGIES

See section 3.2.2 for details on additional QHEI data collected by ODNR staff in the Armstrong Run HUC-12.

Chapter 3: Conditions and Restoration Strategies for Armstrong Run HUC-12 Critical Areas

3.1 OVERVIEW OF CRITICAL AREAS

The single Ohio EPA sample location on the Kokosing River mainstem in the Armstrong Run HUC-12 is at RM 28.6 (Banning Road); it was in attainment of EWH based on data collected in 2007. The main goal of this plan is to ensure the high quality nature of the subwatershed is maintained, as it faces threats to its EWH status. As such, the single critical area identified here is the riparian zone and in-stream habitat of the Kokosing River mainstem throughout the HUC-12 from RM 29.6 to RM 26.1 (Figure 6).

The single critical area identified in this plan is the riparian zone and in-stream habitat of the Kokosing River mainstem throughout the Armstrong Run HUC-12.

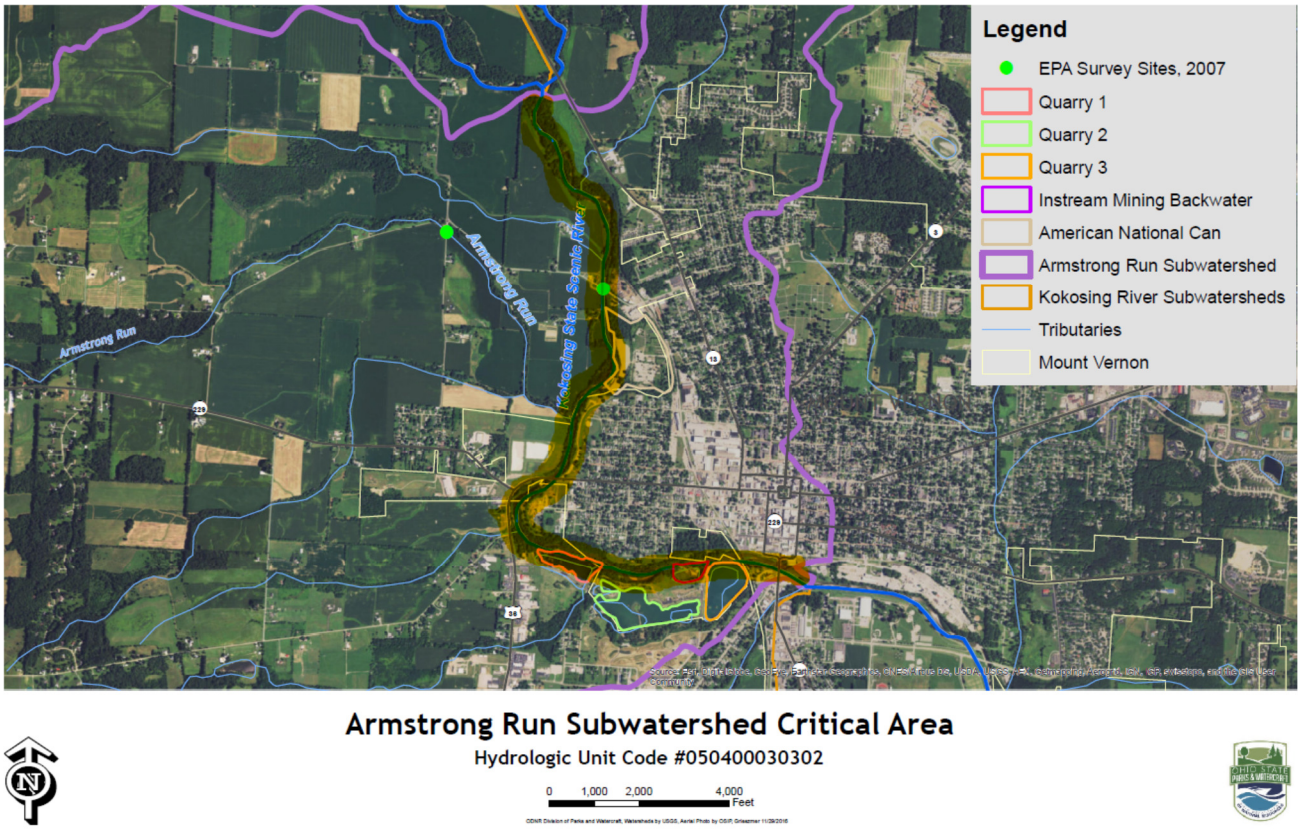

Figure 6: The Armstrong Run Subwatershed critical area is the Kokosing River mainstem channel and riparian zone, indicated in yellow.

3.2 CONDITIONS, GOALS AND OBJECTIVES FOR CRITICAL AREA #1: RIPARIAN ZONE AND CHANNEL OF THE KOKOSING RIVER MAINSTEM

3.2.1 Detailed Characterization

As described in chapter 2.1, land use along the mainstem in this subwatershed varies from agricultural in the northwestern reach to urban and industrial in the southeastern reach. A wooded riparian corridor exists but varies from nonexistent in some sections to more than 500 feet wide in others. The river's high quality is threatened by the legacy of in-stream mining, extensive levees and a recent levee breach into an adjacent quarry lake.

Levees
Earthen levees have been constructed on the banks of the Kokosing River through Mount Vernon for various purposes. According to a Flood Insurance Study conducted by the Federal Emergency Management Agency in 2009, "Levees along the Kokosing River and Dry Creek were constructed after the flood of 1898. This levee system was overtopped and partially destroyed by a major flood in January 1959. Emergency repair work was subsequently performed by the U.S. Army Corps of Engineers" (p. 10). The U.S. Army Corps pursued other flood control measures, including "channel improvements" though Mount Vernon and the completion of a dam on the North Branch of the Kokosing River to create Knox Lake (upstream of the Armstrong Run HUC-12). Despite these efforts, the levee system has been decertified as an adequate mechanism for controlling the 100-year flood (p. 15).

The system has not been comprehensively mapped, but appears to start on the east bank (or left descending bank, when looking downstream) near Banning Road at RM 28.6. A levee also appears to start on the west (or right descending) bank near State Route 36 at RM 27.7, though it is possible that some portion of it was constructed by local landowners to protect farm fields. In some locations, levees were constructed directly on the banks of the river, while at others they occur at a greater distance and allow some floodplain access.

From RM 27.3 to RM 26.4 in present-day Ariel-Foundation Park, the primary purpose of levees constructed on the south/west (right descending) river bank was to separate three quarry lakes from the river and prevent inundation. Levees appear to be continuous from here through the end of the sub-watershed (at RM 26.2), for a total of approximately 1.5 river miles on the left descending bank and 2.4 river miles on the right descending bank. They terminate near the wastewater treatment plant south of Mount Vernon Avenue (near RM 24).

The levee that separates the rivers from the three quarry lakes is a very narrow strip of land with over steepened banks on both sides. This strip is approximately 50 feet wide along Quarry 1 and Quarry 3 (from west to east), with some narrower sections; the riparian corridor separating the river from Quarry 2 is wider. Bank erosion here is generally moderate, ranging to severe in some sections.

The levees have resulted in low sinuosity (or channel curviness) and limited floodplain access. During flood events, powerful, high-velocity flow is trapped in the river channel rather than dissipating by spreading out in the floodplain. This in turn scours the river bed and limits in-stream habitat development, causes problematic bank erosion, and prevents the river from depositing sediment outside of the river channel.

The photos below show the levee at the upstream end of Quarry 1, at RM 27.3. Figure 7 illustrates a somewhat gentle slope and adequate vegetation with stable banks. Some bank armoring with stone and concrete is evident here and in Figure 8. In Figure 9, about 30 feet downstream, severe erosion is evident.

A particularly steep, narrow section occurs downstream at approximately RM 27.25. The city found this point to be quite unstable and reinforced it with new material on the lake side of the levee approximately 10 years ago. Figures 10 and 11 illustrate that the levee here is steep, relatively short, at about 10 feet tall, and very narrow, at just 35 feet wide.

A subsequent 10-year flood event in December, 2017 nearly topped this portion of the levee. Although the levee held, water seeping through it caused material to slump and sheer-off on the quarry side (Figure 12), further weakening the structure.

Figure 7: Levee separating the Kokosing River from Quarry 1, at upstream end near RM 27.3, with adequate vegetation and stable banks.

Figure 8: Armoring of levee at Quarry 1 near RM 27.3.

Figure 9: Levee bank erosion at Quarry 1.

Figures 10 (left) and *11 (below):* A narrow section of levee separating the Kokosing River from Quarry1 at approximately RM 27.3 measures 10 feet tall and 35 feet wide.

Figure 12: Flood water moving through narrow quarry levee at RM 27.3 caused material to slump on quarry side.

The same December, 2017 flood event resulted in a levee breach just downstream at Quarry 1, RM 27.1. The levee is slightly wider here than at RM 27.25, but also slightly lower. Flood water poured over the levee into the lake, which was at a much lower elevation than the river, and eroded the back side of the levee. The overflow eventually eroded through the entire width of the levee until it reached the river. The resulting gap, where the river now flows freely into the quarry, is approximately 100 feet long (Figure 13 and Figure 14).

While the levee system presents challenges to river habitat and ecological processes, the uncontrolled breach that occurred here presents a different set of challenges. Should the breach widen to the extent that the river flows into and is completely captured by the lake, the result would be a complete loss of stream habitat in that reach. A slightly less damaging outcome would be higher flow into the lake from the breach could reduce energy and channel forming flows downstream that inhibits habitat development. Additionally, a large volume of soil was washed into the river and lake when the breach occurred, and additional soil loading will occur as the breach widens.

Figure 13: Levee breech at Quarry 1, RM 27.1, looking east / downstream. The river is located on the left and Quarry 1 on the right.

Figure 14: Side view of levee breach at Quarry 1, RM 27.1, on quarry side looking towards the river.

In-stream mining

Rather than leave a thin strip of land between mining operations and the river, gravel was mined by directly excavating the stream bank between Quarry 1 and Quarry 3 from approximately RM 27.0 (Elm Street) to 26.6 (Norton Street), or approximately 2,400 linear feet. The 1961 U.S. Geological Survey topographic map on the following page (Figure 15) shows the operation in progress with approximately 600 linear feet of river bank removed. Aerial photography from seven years later, circa 1968 (Figure 16), shows the removal of additional upstream and downstream sections, creating an overwide channel.

The river is responding to this over-widened channel by depositing and reworking sediment resulting in braided channels with adjacent backchannels and pond-like areas. These changes in geomorphology and increased channel instability have resulted in significant river bank erosion and subsequent loss of riparian corridor. This reach has an unconsolidated bed due to channel mining extending below the channel bed and the subsequent deposition of recent sediments. The braided channel is unstable, with sediment bars and islands which change with each rain event in some areas. In limited locations, bars and islands have begun to establish vegetation.

Near the end of the in-stream mining reach, the channel flows into what remains of a wide backwater with heavy silt deposits approximately 600 feet long and 250 feet wide. The opening is located at the eastern or downstream reach of the mined area, just upstream of Norton Street (which does not cross the river but continues at a perpendicular angle north and south).

Aerial photography shown in Figure 17 from between 2010 and 2015 shows the dominant channel flowing southeast into the backwater and around an island. More recent aerial photography in Figure 18 shows that flow has shifted. More flow can be seen in the northernmost channel bypassing the backwater as well as additional sediment deposition in the backwater directly south of the island. A site visit in August, 2016 confirmed even less flow into the backwater and a new, northern opening to one of the braided channels north of the island (Figure 19). This migration represents positive channel recovery and reduced flow through the very low-quality habitat backwater (Figure 20).

Quarry 3 can be found just downstream of the mined area (south of the Norton Street corridor), again separated from the river by a long, narrow strip of wooded levee. Here, the portion of the river channel flowing south around the island makes a sharp turn north and then east to rejoin the other channels. Bank erosion at this point is severe as the river makes the turn around the southern, leveed stream bank (Figure 21). The vertically eroding bank here is approximately 15 feet tall and threatens to expose underground utilities. The Mount Vernon Engineering Department reports that the bank lost approximately 10 feet of width in the last seven years (B. Ball, personal communication, August 3, 2016). Similar to the upstream reach near the first quarry, continued erosion here could compromise the levee and result in the river assuming the quarry's path.

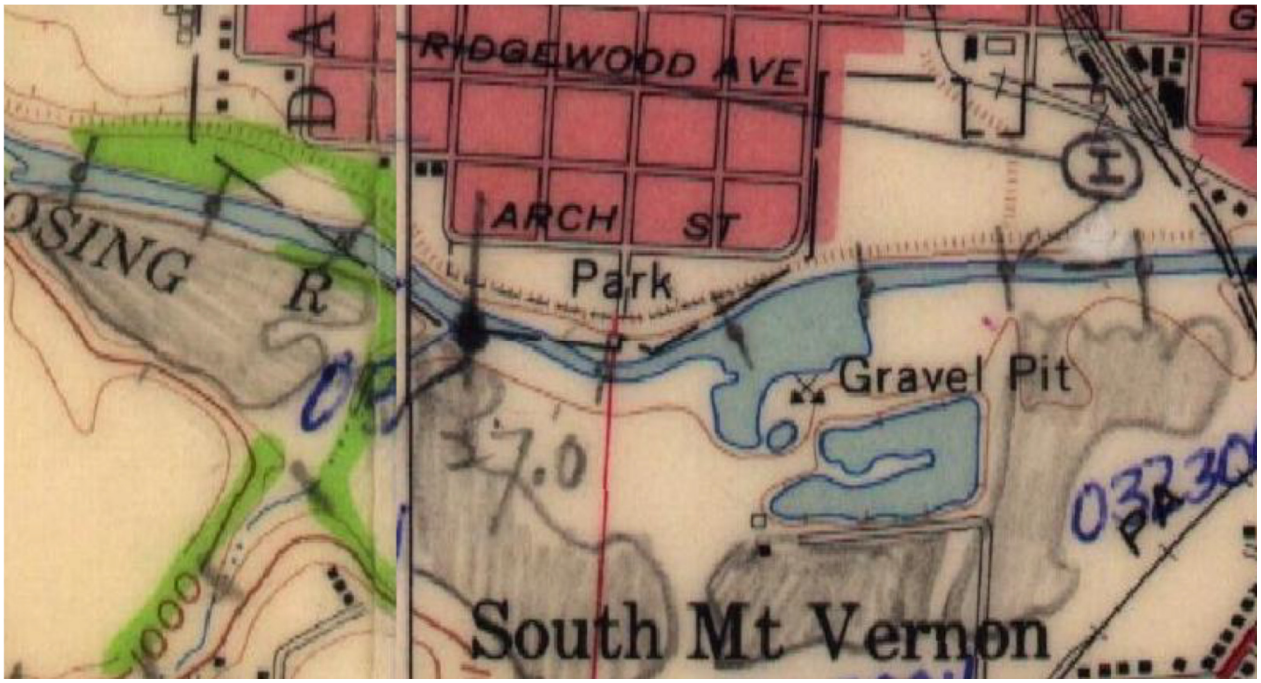

Figure 15: 1961 topographic map shows the beginnings of stream bank gravel mining. Pencil shading was added by Ohio EPA staff to indicate locations of quarries that later followed, though their boundaries also changed.

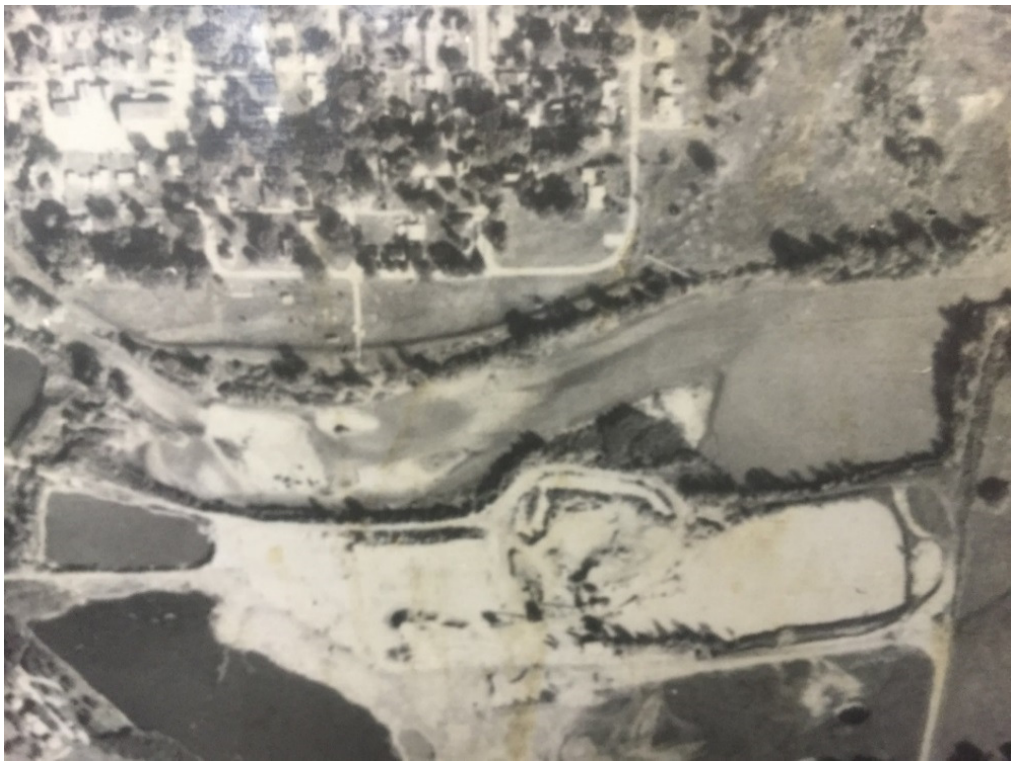

Figure 16: Aerial photography (circa 1968) shows extensive stream bank mining further east and west than shown in 1961 topographic map above. (Image courtesy of City of Mount Vernon Engineering Department)

Figure 17: Aerial photography taken between 2010 and 2015 shows braided river channels upstream of the Norton Street corridor and remnant in-stream mining backwater. The dominant channel with the majority of volume flows into the backwater and south around an island.

Figure 18: Aerial photography generated from Google maps in 2016 shows the increasing size of the northern channel and increasing sediment deposition south of the island.

Figure 19: The braided channel in August, 2016, looking downstream at the head of the island. Arrows, from left to right, show widening northern channel, new opening for a secondary channel north of the main island, and diminishing third channel flowing towards the open backwater south of the island.

Figure 20: Remnant in-stream mining backwater with heavy silt deposits.

Figure 21: Severe bank erosion on the northwest corner of Quarry 3. The Mount Vernon Engineering Department reports that the abandoned pipe protruding above the water extended about 2 feet from the bank five years ago, but now extends much further due to erosion.

Figure 22: The left descending river bank adjacent to Phillips Drive and upstream of Main Street (visible in background) at RM 26.4-26.3 is eroding and unable to support riparian vegetation.

Low-head Dams

A sanitary sewer line crosses the Kokosing River immediately downstream of Main Street and before the terminus of the subwatershed. The line extends approximately nine inches above the normal water level of the river and impounds very little water; a shallow riffle less than 200 feet upstream is visible in the photo below. According the Mount Vernon Engineering Department, the sewer line has been rehabilitated in the last five years (B. Ball, personal communication, May, 15, 2018).

Figure 23: A sanitary sewer line crosses the Kokosing River just downstream of Main Street (and upstream of a multi-use trail bridge visible in the foreground) but is too small to impound a significant amount of water.

3.2.2 Detailed Biological Conditions

Data collected in 2007 at the single Ohio EPA sample site in the critical area, at RM 28.6, showed the mainstem to be in attainment of EWH standards (see Chapter 2.2). However, no data existed for downstream reaches in which habitat alterations threatening the Kokosing River's high quality were evident. ODNR staff collected Qualitative Habitat Evaluation Index (QHEI) data in this lower reach in August, 2016. Two locations were sampled: RM 27.3, adjacent to the upstream section of the first quarry, and RM 26.7 at the in-stream mined section of the river and third quarry (at the Norton Street corridor). Table 3 includes results and a comparison of Ohio EPA QHEI scores for upstream and downstream sites.

Despite the presence of levees and mining, scores for these sites were still in the "good" range. RM 27.3 scored a 75, which is the bottom threshold of habitat quality generally considered necessary to support EWH biological communities.[2] The sample at RM 26.7 received a score of 69, which does not meet the EWH QHEI threshold and is less likely to support EWH biology. Both scores are also significantly lower than those found upstream and downstream in 2007 by the Ohio EPA. This indicates the river has the potential to score much higher in this reach, and reduced habitat quality is a threat to this sub-watershed's high quality status. Neither of these samples reflect the levee breach at the downstream end of the first quarry, at RM 27.1, which occurred subsequently in 2017.

[2] The Ohio EPA does not use QHEI scores to determine attainment status, but rather relies on biological scores (IBI, MIwb, ICI). The QHEI is a qualitative measure of habitat quality and its ability to support living organisms.

Data collection	River Mile	Location	QHEI	Meeting EWH QHEI standard of 75?
2007, OEPA	28.6	Banning Road	82	Yes
2016, ODNR	**27.3**	**Next to Quarry 1, Ariel-Foundation Park**	**75**	**Yes**
2016, ODNR	**26.7**	**At in-stream mining Norton Street Corridor/Quarry 3, Ariel-Foundation Park**	**69**	**No**
2007, OEPA	25.3	Mount Vernon Avenue	82.5	Yes
2007, OEPA	24.3	Glen Road	87.5	Yes

Table 3: Comparison of QHEI scores collected by the Ohio EPA in 2007 and new data collected by ODNR in 2016 (indicated in bold).

QHEI details for RM 27.3

This reach is adjacent to the Quarry 1. The right descending bank (looking downstream) features a narrow, wooded levee that separates the river from the lake with some areas of severe erosion. Bank erosion is of particular concern here because worsening conditions could lead to a breach of an especially narrow section (at RM 27.25) that is 35 feet wide. A levee breach did occur just downstream from this location at RM 27.1, at a section that was slightly wider but lower in elevation.

Riparian width and quality on the left descending bank is good; while a levee is present, it is not located directly on the river bank. Substrates were also good, with normal amounts of siltation and embeddedness. While the channel showed some recovery and moderate stability, sinuosity was quite low; the entire length of the 500 meter sample was nearly visible from the starting point. Habitat development was fair to good, with one run-riffle-pool sequence at the beginning, followed by a long glide with limited habitat quality. In summary, attributes preventing a higher score include low sinuosity, low riparian quality, some severe erosion and limited habitat development.

QHEI details for RM 26.7

This reach spans the Norton Street corridor, including Quarry 3 and 2,400 linear feet of river bank that was mined in the 1960s (see Section 3.2.1.). An unstable, braided channel has resulted, with one channel opening into a residual backwater with heavy silt deposits and very limited habitat quality. In a positive development, the river has shifted a greater degree of its flow towards two northern channels that do not flow through the backwater, but rather north around a large island. This has allowed for some recovery, with limited run-riffle-pool habitat development and areas of good substrate and in-stream cover.

The right descending river bank remains tall and steep here, especially in the transitional area from the backwater to the narrowing channel next to Quarry 3 (at Norton Street). Extreme erosion is of particular concern here because it could lead to a levee breach. The left descending bank contains better riparian quality; although a levee does limit floodplain access, it is not found directly on the river banks.

Poor habitat quality continues downstream as the river passes under a railroad bridge and continues to Main Street at RM 26.3. Glide habitats dominate, with almost no run-riffle-pool development. Riparian quality and in-stream cover is poor and floodplain access nearly non-existent due to levees and channel incision. The left descending bank, adjacent to Phillips Street, is very steep and eroding and supports very little vegetation (Figure 22). In summary, attributes that prevent a higher score include low channel stability and sinuosity, severe erosion (in spots), poor floodplain and riparian quality, and silt substrates.

3.2.3 Detailed causes and sources

The causes and sources of impairment discussed here are the same as those discussed in Section 2.3. No causes and sources of impairment are identified in the Armstrong Run HUC-12 according to the Ohio EPA's 2010 Kokosing River water quality report, and accordingly, none are listed in the Ohio EPA's 303d list of impaired waters (Ohio EPA, 2016). Rather than reverse impairments, the overall goal of this plan is to protect this high-quality waterway by addressing threats. It is threatened by habitat alterations that occurred downstream of the Ohio EPA sample point at Banning Road (RM 28.6) and the terminus of the subwatershed. Based on additional QHEI data collected by ODNR in August, 2016, potential causes and sources of impairment that threaten the Kokosing's exceptional warmwater habitat aquatic life use are:

Causes of Impairment	**Sources of Impairment**
Direct habitat alteration	In-stream and floodplain mining
Siltation	In-stream mining, levees
Channelization	Levees

Direct habitat alteration resulted from in-stream mining in the 1960s which removed approximately 2,400 linear feet of river bank and riparian corridor. The effects of mining are still present in the form of channel instability, excessive siltation (within a remaining open backwater area with thick silt deposits) and bank erosion.

Channelization of the river through an extensive levee system also contributes to siltation and reduced in-stream habitat development. During flood events, levees prevent the river from accessing its floodplain to dissipate the force of flood water or deposit sediment outside of the channel. Scouring that occurs during flood events prevents in-stream habitat (such as run-riffle- pool sequences) from developing.

Levees also present a long-term challenge because they narrowly separate the river from a series of quarry lakes, which were the result of gravel mining in the floodplain. A breach of one of these levees occurred in December, 2017 during a 10-year flood event, which further threatens the integrity of the river channel. Additional breaches continue to be a threat in this area.

3.2.4 Outlined Goals and Objectives for the Critical Area

Goals

The overall nonpoint source pollution goal of this plan is to protect the Armstrong Run HUC-12 as a high-quality waterway and to maintain existing attainment of its EWH aquatic life use designation. New QHEI data illustrate that direct habitat alterations, siltation and channelization threatens this status. Therefore, the primary goals for this critical area are to increase QHEI scores where they are marginally meeting or are below the EWH threshold score of 75, at reaches near RM 27.3 (quarry 1) and RM 26.7 (Norton Street corridor/Quarry 3). The reach near RM 27.3 includes the area where a levee breach occurred after data were collected, which would have further degraded habitat and QHEI scores in that section.

No biological data are available at these points, though it is anticipated that post-project surveys will find biological indices here in attainment of EWH within a few years. It is also anticipated that the biological indices currently in attainment just upstream at the Banning Road sample site (RM 28.6) will be maintained.

Goal 1: Maintain IBI score of 48 at Banning Road site (RM 28.6)

Goal 2: Maintain MIwb score of 9.3 at Banning Road site (RM 28.6)

Goal 3: Maintain ICI score of 52 at Banning Road site (RM 28.6)

Goal 4: Maintain QHEI score of 82 at Banning Road site (RM 28.6)

Goal 5: Increase QHEI score from 75 to 80 at Quarry #1 (RM 27.3)

Goal 6: Increase QHEI score from 69 to 75 at Norton Street / Quarry #3 (RM 26.7)

Objectives

In order to achieve the overall goal of protecting full attainment of this critical area by removing threats to improve QHEI scores, the following objectives need to be achieved. They are prioritized management measures and will be the primary objectives as projects are developed to maintain EWH status.

Objective 1: Restore and repair 2025 linear feet of streambank using natural channel design techniques.

Objective 2: Restore the river's connection to 90 acres of adjacent floodplain.

Objective 3: Restore 26 acres of riparian zone.

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. Objectives will be reevaluated and modified as necessary.

Chapter 4: Projects and Implementation Strategy

4.1 PROJECT AND IMPLEMENTATION STRATEGY OVERVIEW TABLE

Below are the projects and evaluation needs believed to be necessary to protect the high quality of the Armstrong Run HUC-12 and address causes and sources of nonpoint source pollution threatening this quality. Because attainment status is based on biological conditions, it will be necessary to periodically re-evaluate the status of the critical area to determine if the implemented projects are sufficient to achieve restoration. Time is an important factor to consider when measuring project success and overall status. Biological systems, in some cases, can show response within as little as one season, while in others, may take several seasons or years to recover. There may also be sources other than nonpoint source pollution which would be addressed under different initiatives, authorities or programs.

A Project and Implementation Strategy Overview Table for the single critical area identified in the Armstrong Run HUC-12 is below. The projects described in the overview table have been prioritized using the following three step prioritization method:

- Priority 1 - Projects that specifically address one or more of the listed objectives for the critical area.
- Priority 2 - Projects where there is landowner willingness to engage in projects designed to address threats or when there is an expectation that such projects will improve and protect water quality in the Armstrong Run HUC-12 subwatershed.
- Priority 3 - In an effort to generate interest in projects, an information and education campaign will be developed and implemented. Such outreach will engage citizens to spark interest in stakeholder participation and implementation in projects.

Information listed in the overview table comes from Project Summary Sheets (PSS) in Section 4.2. These PSSs provide the essential nine elements for short-term and/or next step projects which are in development and/or in need of funding. PSS sheets for medium and long-term projects are not included as they are not ready for implementation. As short- term projects are implemented and new projects developed these sheets will be updated. Any new PSS will be submitted to the Ohio EPA for funding eligibility verification (i.e., all nine elements are included).

Critical Area 1: Project Overview Table for Armstrong Run HUC-12 05040003 03 02							
Goal	Objective	Project #	Project Title	Lead Organization	Time Frame	Estimated Cost	Potential /actual funding source
Altered Stream and Habitat Restoration Strategies							
6	1, 3	1	Norton Street stream bank restoration	Mount Vernon	Short	$130,000	Ohio EPA 319, Mount Vernon
5, 6	1, 2	2	High flow floodplain connector at Quarry 1	Mount Vernon	Short	$140,000	Ohio EPA 319, Mount Vernon, Muskingum Watershed Conservancy District (MWCD)
5, 6	2, 3	3	Levee set-back and floodplain restoration, West High Street to Norton Street	Mount Vernon	Long	---	Ohio EPA 319, Mount Vernon, MWCD
5, 6	2, 3	4	Levee set-back and floodplain restoration, Tilden Avenue to West High Street	Mount Vernon	Long	---	Ohio EPA 319, Mount Vernon, MWCD
6	1, 3	5	Phillips Street streambank and riparian zone restoration	Mount Vernon	Short	$240,000	Ohio EPA 319, Mount Vernon, Knox County Community Foundation, MWCD

4.2 PROJECT SUMMARY SHEETS

The Project Summary Sheets provided on the following page were developed based on the actions needed to maintain attainment of this high quality river and address threats to the Exceptional Warmwater Habitat aquatic life use designation of the Armstrong HUC-12 subwatershed. These projects are considered next step or priority/short-term projects.

Critical Area 1: Project 1		
Nine Element Criteria	**Information needed**	**Explanation**
n/a	Title	**Norton Street Stream Bank Restoration**
criteria D	Project Lead Organization and Partners	Mount Vernon Engineering Department
criteria C	HUC-12 and Critical Area	Armstrong Run HUC-12 (05040003 03 02) Critical Area 1: Kokosing River in-stream habitat and riparian zone
criteria C	Location of Project	Kokosing River at Norton Street, RM 26.3 - 26.7
n/a	Which strategy is addressed by this project?	Altered Stream and Habitat Restoration Strategy
criteria F	Time Frame	Short (1-3 years)
criteria G	Short Description	Employ natural channel design techniques to restore previously mined river bank and repair severe bank erosion. Plant restored riparian zone with native vegetation.
criteria G	Project Narrative	Approximately 2,400 linear feet of the Kokosing River bank was mined for gravel in the 1960s resulting in unstable, braided channels, bank erosion, and a remnant open backwater with thick silt deposits within one of the channels. The City of Mount Vernon will utilize natural channel design techniques to restore 700 linear feet of river bank to disconnect the backwater channel. The backwater will be converted to riparian zone with functional floodplain, which will accept sediment deposits, reduce in-stream velocity and reduce bank erosion during high flow events. Restoring the river channel and providing floodplain will improve in-stream substrates and habitat development. A log revetment extending 400 linear feet will also support a severely eroding bank at the downstream end of the mined reach (at Norton Street, adjacent to Quarry 3). Restoration of 4 acres of riparian zone will be completed by planting approximately 1,200 native trees and shrubs and native forb/grass seed mix. Vegetation will stabilize soil to prevent erosion, as well as provide a wide array of benefits associated with wooded riparian buffers: surface runoff filtration, sediment deposition, in-stream cover, shading to lower water temperature and increase dissolved oxygen, and supporting the base of the food web with organic debris.
criteria D	Estimated Total cost	$130,000
criteria D	Possible Funding Source	Ohio EPA 319; City of Mount Vernon
criteria A	Identified Causes and Sources	Cause: Direct Habitat Alteration, Siltation Source: In-stream mining, Levees

Critical Area 1: Project 1, *continued*		
Nine Element Criteria	**Information needed**	**Explanation**
	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	The Armstrong Run HUC-12 critical area in not impaired; it is a high quality waterway that faces habitat-related threats to its Exceptional Warmwater Habitat (EWH) status. The project goal is to maintain biological indices in the Armstrong Run HUC-12 at EWH, and to improve the QHEI score in this reach from 69 to 75 in support of biological communities. Plan objectives include: • *Objective 1:* Restore and repair 2025 linear feet of streambank using natural channel design techniques. • *Objective 2:* Restore the river's connection to 90 acres of adjacent floodplain. • *Objective 3:* Restore 26 acres of riparian zone.
criteria B & H	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	• *Objective 1:* 1,100 of 2,025 linear feet of stream bank restoration, or 54%, will be accomplished. • *Objective 3:* 4 of 26 acres of riparian restoration, or 15%, will be accomplished. There is often a lag time associated with nonpoint source-related projects and measured stream response. With respect to the goals in critical area 1, the main driver is QHEI. Current data shows that the score in this reach is 69, which is six points below the attainment score of 75. It is expected this project will cause an incremental increase in the QHEI score by five points, with similar percentage gains for IBI, ICI and MIwb index scores. It also expected that project #2 (just upstream of the Norton Street corridor) will increase the QHEI score here by one point. Between the two projects, the score is expected to increase by a total of six points. When all projects presented in this plan are completed, 100% of Objective 1 and Objective 3 will be achieved.
	Part 3: Load Reduced?	337 tons sediment per year
criteria I	How will the effectiveness of this project in addressing the NPS impairment be measured?	Staff from OEPA-DSW Ecological Assessment Until will perform both pre-and post-project monitoring. In addition, the Banning Road sampling site will also be monitored (as part of the Ohio EPA's ongoing surface water monitoring program cycle) to determine progress (through IBI, ICI and QHEI) in maintaining EWH and limiting threats. The next comprehensive water quality assessment of Kokosing River is scheduled for 2023, according to Ohio EPA's 2016 Integrated Report (http://epa.ohio.gov/Portals/35/tmdl/2016intreport/MonitSched_2016.pdf).
criteria E	Information and Education	This project will be promoted with project signage, press releases, newsletter articles and public programs. City staff will present the project to local civic organizations and schools.

Critical Area 1: Project 2		
Nine Element Criteria	Information needed	Explanation
n/a	Title	**High flow floodplain connector at Quarry #1**
criteria D	Project Lead Organization & Partners	Mount Vernon Engineering Department
criteria C	HUC-12 & Critical Area	Armstrong Run HUC-12 05040003 03 02, Critical Area 1 Kokosing River instream habitat and riparian zone
criteria C	Location of Project	Kokosing River at Quarry 1, Ariel-Foundation Park, RM 27.3 – 27.1
n/a	Which strategy is addressed by this project?	Altered Stream and Habitat Restoration Strategy
criteria F	Time Frame	Short (1-3 years)
criteria G	Short Description	Restore river bank, create a high flow floodplain connection and create stable riparian habitat.
criteria G	Project Narrative	This project will partially replace a failed gravel quarry levee by building 125 linear feet of lowered river bank (utilizing natural channel techniques) and a high flow (5-year flood elevation) connector. This structure will allow flows from the Kokosing River to interact with adjacent floodplain on the right descending bank within Ariel-Foundation Park. Benefits will include restored connection with adjacent floodplain, reduced river channelization, reduced sediment transport, improved riparian corridor stability and improved in-stream habitat development.
criteria D	Estimated Total cost	$140,000
criteria D	Possible Funding Source	Ohio EPA 319; City of Mount Vernon; Muskingum Watershed Conservancy District
criteria A	Identified Causes and Sources	Cause - Source: Siltation – In-stream mining, levees Channelization – levees
criteria B & H	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	The Armstrong Run HUC-12 critical area in not impaired; it is a high quality waterway that faces habitat-related threats to its Exceptional Warmwater Habitat (EWH) status. The project goal is to maintain biological indices at EWH, and to improve the QHEI score in this reach from 75 to 80. Plan objectives include: • *Objective 1:* Restore and repair 2025 linear feet of streambank using natural channel design techniques. • *Objective 2:* Restore the river's connection to 90 acres of adjacent floodplain. • *Objective 3:* Restore 26 acres of riparian zone.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	• *Objective 1:* 125 of 2,025 linear feet of stream bank restoration, or 6%, will be accomplished. • *Objective 2:* 75 of 90 acres of floodplain connection, or 83%, will be accomplished. There is often a lag time associated with nonpoint source-related projects and measured stream response. With respect to the goals in critical area 1, the main driver is QHEI. Current data shows that the score at RM 27.3 is 75, which is on the brink of meeting the EWH index score. It is expected that this project will cause an incremental increase in the QHEI score by 5 points at RM 27.3 with similar percentage gains for IBI, ICI and MIwb index scores. When all projects presented in this plan are completed, 100% of Objective 1 and Objective 2 will be achieved.

Critical Area 1: Project 2, *continued*		
Nine Element Criteria	Information needed	Explanation
	Part 3: Load Reduced?	42 tons sediment per year
criteria I	How will the effectiveness of this project in addressing the NPS impairment be measured?	Staff from OEPA-DSW Ecological Assessment Until will perform both pre-and post-project monitoring. In addition, the Banning Road sampling site will also be monitored (as part of the Ohio EPA's ongoing surface water monitoring program cycle) to determine progress (through IBI, ICI and QHEI) in maintaining EWH and limiting threats. The next comprehensive water quality assessment of Kokosing River is scheduled for 2023, according to Ohio EPA's 2016 Integrated Report (http://epa.ohio.gov/Portals/35/tmdl/2016intreport/MonitSched_2016.pdf).
criteria E	Information & Education	This project will be promoted with project signage, press releases, and newsletter articles. City staff will present the project to local civic organizations and schools.

Critical Area 1: Project 3		
Nine Element Criteria	Information needed	Explanation
n/a	Title	**Phillips Street River Bank Stabilization**
criteria D	Project Lead Organization & Partners	Mount Vernon Engineering Department
criteria C	HUC-12 & Critical Area	Armstrong Run HUC-12 05040003 03 02, Critical Area 1 Kokosing River instream habitat and riparian zone
criteria C	Location of Project	Phillips Drive riparian corridor between railroad crossing and Main Street, RM 26.4
n/a	Which strategy addressed by this project?	Altered Stream and Habitat Restoration Strategy
criteria F	Time Frame	Short (1-3 years)
criteria G	Short Description	This project will stabilize a failing river bank by constructing a limited stone toe with soil backfill and revegetation and stone vanes.
criteria G	Project Narrative	This project will stabilize a failing river bank that currently does not support a riparian corridor. The project will reconstruct 800 linear feet of the bank with limited stone toe with soil backfill and revegetation on the left descending river bank. Revegetation wiyh native trees, shrubs and grasses will also occur on the right descending river bank; total area will include 2 acres. Vanes will be installed in the river to support bank stabilization and improve in-stream habitat development.
criteria D	Estimated Total cost	$240,000
criteria D	Possible Funding Source	Ohio EPA 319; City of Mount Vernon
criteria A	Identified Causes and Sources	Cause - Source: Direct habitat alteration - In-stream and floodplain mining Channelization – levees
criteria B & H	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	The Armstrong Run HUC-12 critical area in not impaired; it is a high quality waterway that faces habitat-related threats to its Exceptional Warmwater Habitat (EWH) status. The project goal is to maintain biological indices at EWH, and to improve the QHEI score in this reach from 69 to 75. Plan objectives include: • *Objective 1:* Restore and repair 2,025 linear feet of streambank using natural channel design techniques. • *Objective 2:* Restore the river's connection to 90 acres of adjacent floodplain. • *Objective 3:* Restore 26 acres of riparian zone.

Critical Area 1: Project 3, *continued*		
Nine Element Criteria	**Information needed**	**Explanation**
criteria B & H	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	• *Objective 1:* 800 of the 2,025 linear feet of stream bank repair, or 40%, will be accomplished. • *Objective 3:* 2 of 26 acres of riparian zone restoration, or 8%, will be accomplished. There is often a lag time associated with nonpoint source-related projects and measured stream response. With respect to the goals in critical area 1, the main driver is QHEI. Current data shows that the score in this reach is 69, which is six points below the attainment index score of 75. It is expected this project will cause an incremental increase in the QHEI score by four points, with similar percentage gains for IBI, ICI and MIwb index scores. It also expected that project 1, which will occur just upstream of the Norton Street corridor, will increase the QHEI score here by two point. Between the two projects, the score is expected to increase by a total of six points. When all projects presented in this plan are completed, 100% of Objective 1 and Objective 3 will be achieved.
	Part 3: Load Reduced?	262 tons sediment per year
criteria I	How will the effectiveness of this project in addressing the NPS impairment be measured?	Staff from OEPA-DSW Ecological Assessment Until will perform both pre-and post-project monitoring. In addition, the Banning Road sampling site will also be monitored (as part of the Ohio EPA's ongoing surface water monitoring program cycle) to determine progress (through IBI, ICI and QHEI) in maintaining EWH and limiting threats. The next comprehensive water quality assessment of Kokosing River is scheduled for 2023, according to Ohio EPA's 2016 Integrated Report (http://epa.ohio.gov/Portals/35/tmdl/2016intreport/MonitSched_2016.pdf).
criteria E	Information & Education	This project will be promoted with project signage, press releases, and newsletter articles. City staff will present the project to local civic organizations and schools.

Appendix

ACRONYMS

EPA – Environmental Protection Agency
EWH – Exceptional Warmwater Habitat
HUC – Hydrologic Unit Code
IBI – Index of Biotic Integrity
ICI – Invertebrate Community Index
MIwb – Modified Index of Wellbeing
NPS – Nonpoint Source pollution
ODNR – Ohio Department of Natural Resources
QHEI – Qualitative Habitat Evaluation Index
RM – River Mile
WWH – Warmwater Habitat
USACE – United States Army Corps of Engineers

INDEX OF FIGURES AND TABLES

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