Buckeye Lake Reservoir Feeder HUC-12 (05040006 04 04)

Nine-Element Nonpoint Source Implementation Strategic Plan (NPS-IS Plan)
Version 1.0
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Created by:
Perry Soil and Water Conservation District
109 E Gay St.
Somerset, Ohio 43783

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Acknowledgments

The Perry Soil and Water Conservation District would like to thank its numerous partners committed to the water quality of Buckeye Lake. This NPS-IS plan will be used as a basis for addressing nonpoint source impairment in the Buckeye Lake Reservoir Feeder.

- Buckeye Lake for Tomorrow, Inc. – a non-profit devoted to improving the water quality of Buckeye Lake by collecting data and advocating for better land management in the watershed. The organization remains an invaluable source of information, on matters of both science and community.

- Buckeye Lake Region Corporation – a tri-county alliance dedicated to uniting political and civil entities across Buckeye Lake, with the goal of enhancing the economic prosperity of the region.

- The County Commissioners for Fairfield, Licking, and Perry Counties – who have provided funding and support for watershed initiatives.

- Fairfield and Licking Soil and Water Conservation Districts – the SWCDs have contributed staff time and knowledge to developing the NPS-IS plan for both watersheds in the Buckeye Lake region. Due to previously established relationships, the SWCDs also provide contact with producers.

- The Health Departments of the three counties (Fairfield, Licking, and Perry) – who have offered support and opportunities for collaboration on home sewage treatment system inspections.

- Landowners, producers, and other private stakeholders – landowners in the watershed serve as principal members of Buckeye Lake for Tomorrow and Buckeye Lake Region Corporation. They have been instrumental in organizing activities that improve water quality.

- Natural Resources Conservation Service – an agency of the US Department of Agriculture, NRCS serves to promote best management practices for producers through expertise and cost-share programs. A relationship with NRCS has opened opportunities to develop conservation projects on private property in the watershed.

- Ohio Department of Agriculture – ODA has provided funding for a Buckeye Lake watershed coordinator. Engineering staff has also been made available for the development of projects.

- Ohio Department of Natural Resources – ODNR manages Buckeye Lake State Park and maintains the Reservoir Feeder channel. By working with their Division of State Parks and Watercraft, several potential projects have been identified on public land.

- Ohio Environmental Protection Agency – data collected during OEPA's routine water monitoring was included in this document. OEPA has also funded its own study of the watershed (Tetra Tech, 2014).

- South Licking Watershed Conservancy District – the conservancy district has offered expertise on water quality matters in the greater South Licking HUC-10.

Chapter 1: Introduction

The Buckeye Lake Reservoir Feeder (HUC 05040006 04 04) is located approximately 25 miles east of Columbus. It is divided across two counties (Licking to the north and Fairfield to the south) and funnels water eastward into Buckeye Lake through the Reservoir Feeder channel (also referred to as the Kirkersville Feeder Canal), an artificial ditch that diverts natural tributaries away from the South Fork of the Licking River and toward the lake. The land in this watershed is dominantly used for agriculture.

Buckeye Lake has been plagued by harmful algal blooms (HABs) over the last decade and longer. These blooms have caused periodic summer closures and can threaten the safety of recreational water users as well as the economic viability of the lake. To reduce the outbreak of HABs, steps must be taken to address water quality issues across the lake's two drainage areas: the Buckeye Lake watershed (05040006 04 03), of which an NPS-IS has already been written, and the Buckeye Lake Reservoir Feeder watershed (05040006 04 04), which this NPS-IS covers.

1.1 Report Background

One of the primary studies on water quality in the Reservoir Feeder is the Buckeye Lake Nutrient Reduction Plan (Buckeye Lake for Tomorrow, 2013). A watershed inventory was conducted in 2012-2013, and a report was compiled for the Ohio Environmental Protection Agency (EPA) which described nutrient control strategies that would prevent excessive harmful algal blooms. Buckeye Lake for Tomorrow (BLT), a 501(c)(3) corporation, took the lead on writing this document with assistance from the Fairfield Soil and Water Conservation District. Buckeye Lake 2036, a committee dedicated to realizing the economic vision of the Buckeye Lake Region Corporation, was also instrumental in gathering support for water quality improvements in the lake. The Fairfield, Licking, and Perry Soil and Water Conservation Districts (SWCDs) now carry forward project planning with quantifiable targets for nonpoint-source pollution reduction, a responsibility which includes writing NPS-IS plans such as this one.

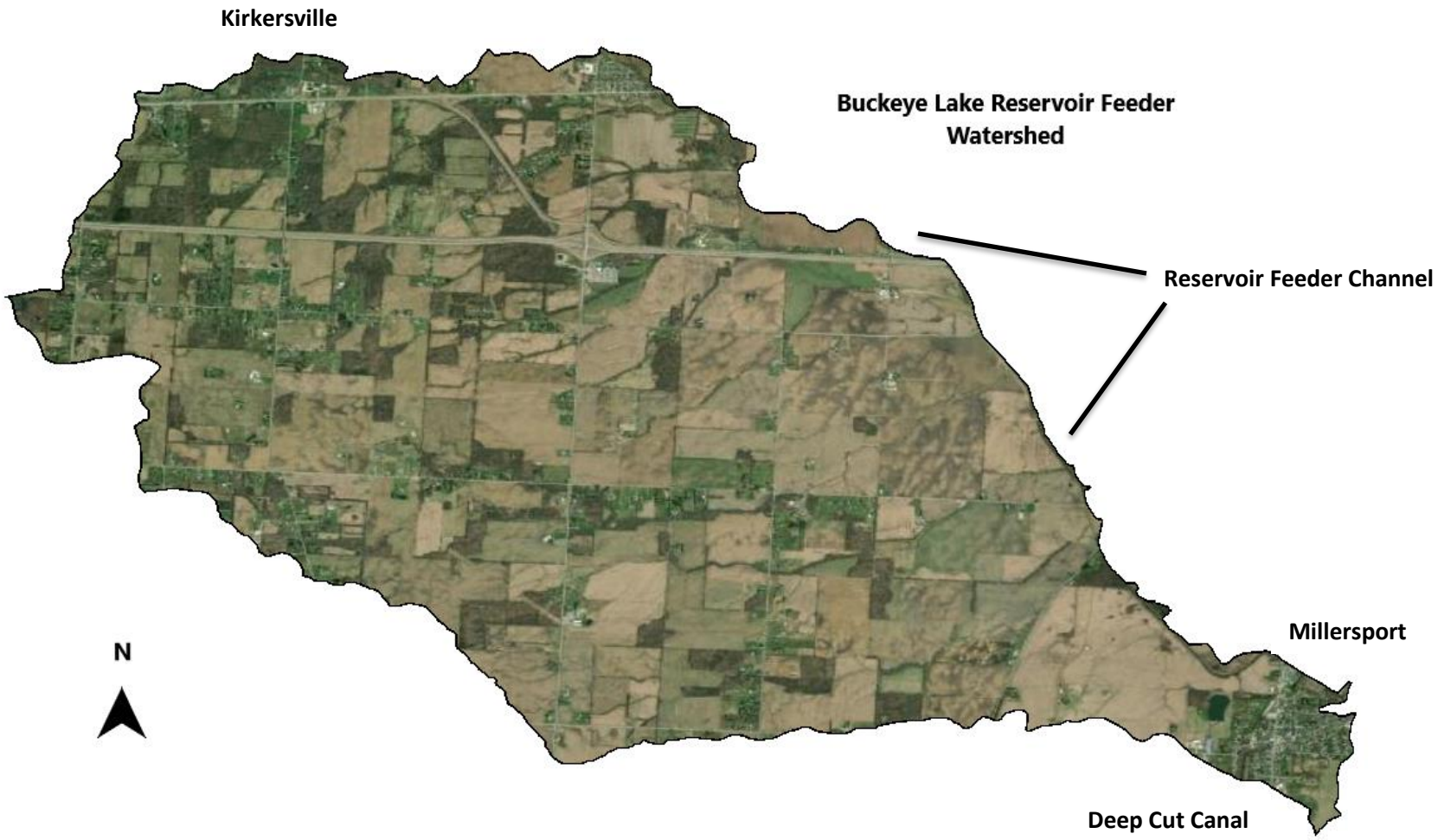

Figure 1. Map of the Buckeye Lake Reservoir Feeder Watershed (05040006 04 04) boundary

1.2 Watershed Profile & History

The Buckeye Lake Reservoir Feeder is one of two HUC-12s that drain into the 3,200-acre Buckeye Lake. There are an estimated 11,024 acres in the watershed, over 60% of which are cultivated crops (Figure 1). Whereas the eastern HUC-12 contains the lake itself and surrounding municipalities, there is little open water or development in this western HUC-12. The most significant feature is the Feeder channel, which forms the northern boundary of the watershed and directs drainage from over a dozen tributaries toward the lake. Among all waterways draining into Buckeye Lake, the Feeder is the largest. The reason that 11,024 total acres is an estimate is because a diversion structure exists near Kirkersville that sends some water east through a ditch. Except for during high flows, it is believed that no water drains toward Buckeye Lake north of this ditch. If confirmed, that would make the total drainage area up to 30% smaller. The primary land use in the Buckeye Lake Reservoir Feeder HUC-12 is row-crop agriculture (61.2%), followed by forest cover (14.7%), pasture/hay (11.7%), and urban development (10.5%) (Figure 2) (Buckeye Lake for Tomorrow, 2013).

Buckeye Lake was constructed in the 1820s as part of the Ohio and Erie Canal Project with the intent that it would maintain canal water levels (EMH&T, 2016). To build this reservoir, a four-mile long earthen dike was constructed to block drainage into the South Fork Licking River. The reservoir was completed in 1830, but because insufficient water flowed into the dike to operate the canal, the impoundment was enlarged, and the feeder channel was built to divert water from the South Fork Licking River toward the lake. When the canal system closed in the late 1800s, the State of Ohio took ownership and turned the lake area into a public park, naming it Buckeye Lake. Recreational use and urban development subsequently increased in the early 1900s, and in 1949, Buckeye Lake became a state park under the management of the Ohio Department of Natural Resources (ODNR) (EMH&T, 2016).

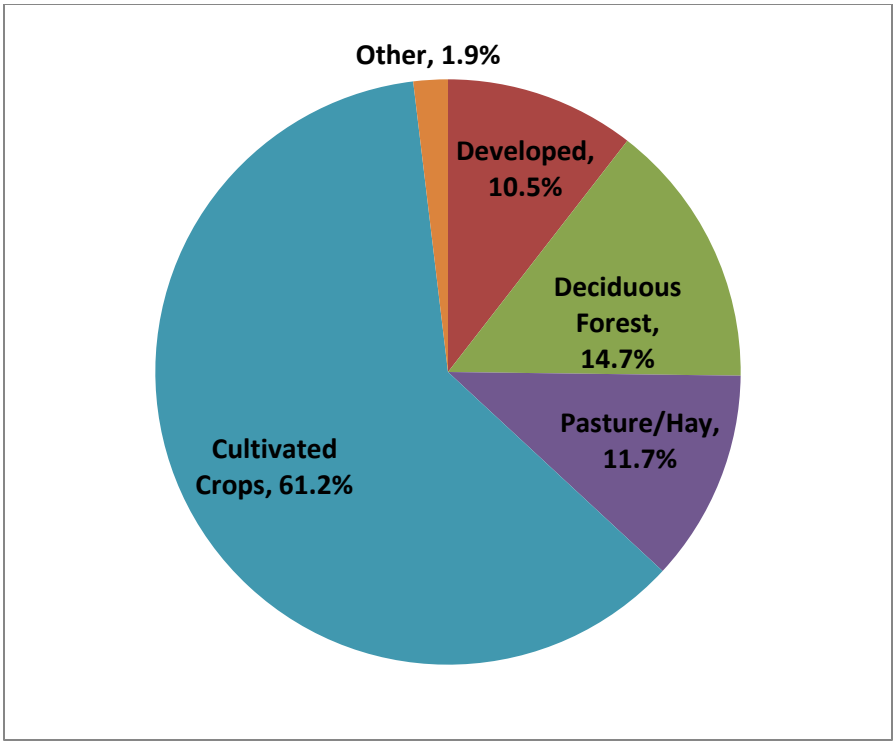

Figure 2. Land use in the Reservoir Feeder HUC-12

1.3 Public Participation & Involvement

Diverse involvement is necessary for any watershed restoration plan. Government organizations, businesses, non-profit groups and landowners all have distinct roles in bringing the plan into action. To facilitate connection between these groups, the Perry Soil and Water Conservation District obtained a grant from the Ohio Department of Agriculture to hire a Buckeye Lake watershed coordinator. This NPS-IS Plan serves as a comprehensive action statement for the Reservoir Feeder HUC-12.

Preliminary work was done in 2011-2012 to assess the water quality in Buckeye Lake and at the Feeder:

- Buckeye Lake for Tomorrow (BLT) conducted water quality sampling at 17 sites across the lake and its tributaries (Figure 3).
- The Fairfield County Soil and Water Conservation District, completed a comprehensive inventory of all streams in the two watersheds, covering over 77 miles of waterways and documenting existing farm tiles, pipes, log jams, erosion sources, and riparian conditions.

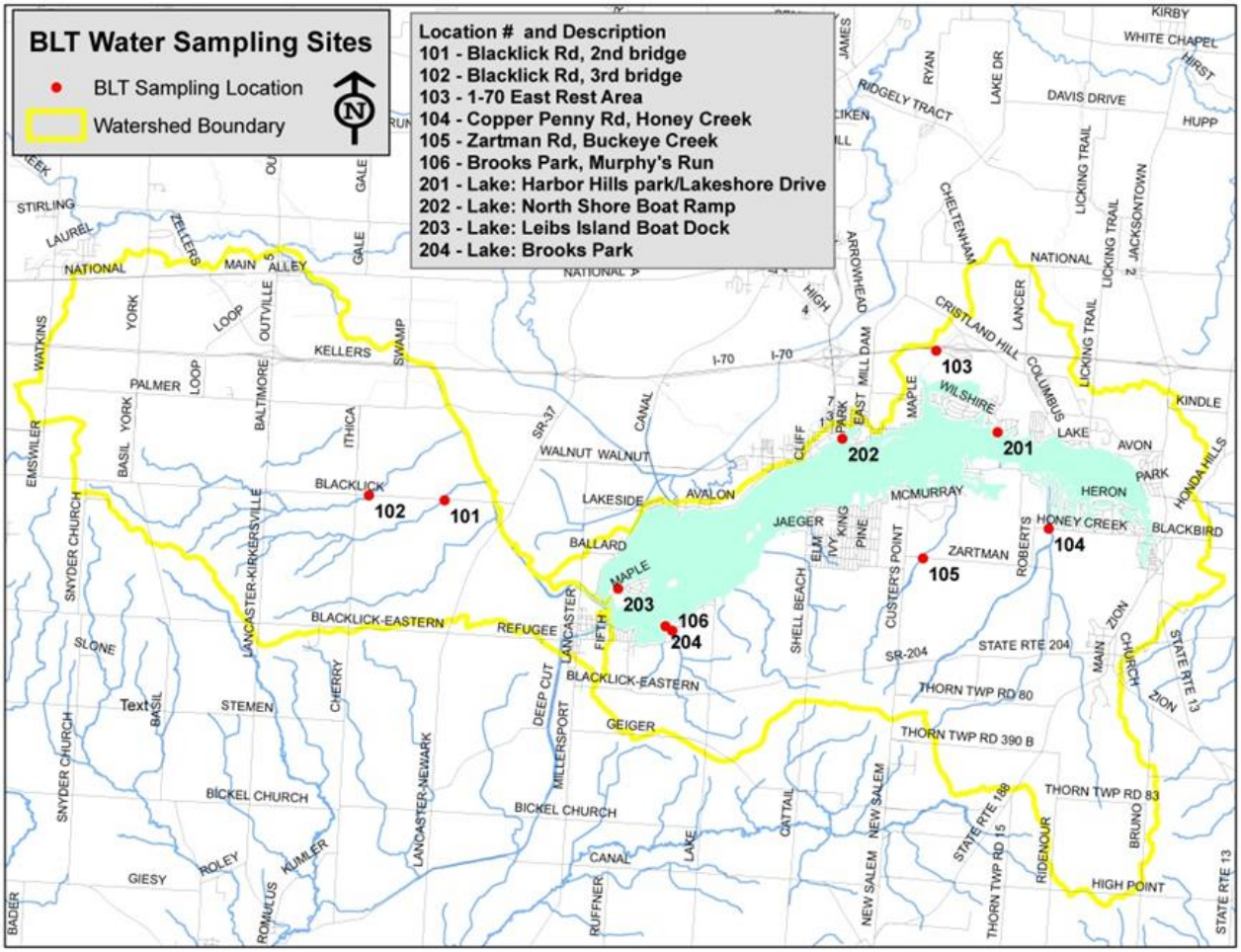

Figure 3. Buckeye Lake for Tomorrow's sampling locations

In 2013, BLT wrote a Nutrient Reduction Plan which identified potential nutrient reduction methods and served as guidance for this NPS-IS. Another valuable study is the Buckeye Lake Preliminary Investigation, conducted by EMH&T engineering consultants in 2016. The purpose of this report was to summarize existing data and suggest lake management strategies for sediment removal, pollutant load reduction, and recreational pool level maintenance.

Community engagement will be crucial to implementing the projects listed in this NPS-IS, especially engagement from local producers. To assist in partnering with producers, Natural Resources Conservation Service (NRCS) has offered support through incentive programs, namely the Environmental Quality Incentives Program (EQIP). Farm Service Agency (FSA) also offers support to producers in the form of their Conservation Reserve Program (CRP), another incentive program that provides cost-share funding for farmers.

Chapter 2: Reservoir Feeder HUC-12 Watershed Characterization and Assessment Summary

2.1 Summary Watershed Characterization for the Reservoir Feeder HUC-12

2.1.1 Physical and Natural Features

The South Fork Licking River HUC-10 watershed is made up of nine subwatersheds, two of which drain into Buckeye Lake: the Buckeye Lake watershed (05040006 04 03) and the Buckeye Lake Reservoir Feeder watershed (05040006 04 04). This document focuses on the Buckeye Lake Reservoir Feeder watershed, located on the southern border of the South Fork Licking River HUC-10. The principal waterway which flows into Buckeye Lake from this watershed is the Feeder channel, which funnels the water from over a dozen tributaries toward the lake, encompassing a drainage area of between 11.9 and 16.9 square miles. The true drainage value is unknown: a northern diversion structure near Kirkersville sends some of the water east through a ditch named the Pigeon Swamp ditch. Except during very high flows, it is believed no water drains toward Buckeye Lake north of this ditch (Tetra Tech, 2014).

Agriculture accounts for more than 60% of the land use designation in the Reservoir Feeder watershed (Table 1). Development accounts for roughly 10%. Soils throughout the region are poorly drained to moderately well-drained, mostly in glacial till over Mississippian bedrock. There are over 257,893 feet (48.84 miles) of waterways in the watershed (Buckeye Lake for Tomorrow, 2013).

Specific landmarks and features in this HUC-12 include:

- The Feeder Channel
- Part of the Deep Cut canal
- Part of Millersport
- Kirkersville
- Interstate 70
- Several cemeteries
- The Millersport Sewage Treatment Plant
- Farm fields and residential housing

2.1.2 Land Use

Land Use Category	Reservoir Feeder HUC-12 Total Acres	Reservoir Feeder HUC-12 Percentage
Open Water	15.35	0.1%
Developed Open Space	683.64	6.2%
Developed Low Intensity	373.18	3.4%
Developed Medium Intensity	91.40	0.8%
Developed High Intensity	11.56	0.1%
Barren Land	0.00	0.0%
Deciduous Forest	1,621.93	14.7%
Evergreen Forest	4.45	0.0%
Mixed Forest	0.00	0.0%
Shrub/Scrub	53.82	0.5%
Grassland/Herbaceous	87.85	0.8%
Pasture/Hay	1,293.00	11.7%
Cultivated Crops	6,746.57	61.2%
Woody Wetlands	41.59	0.4%
Emergent Herbaceous Wetland	0.00	0.0%
Total Acreage	11,024.34	100%

Table 1. Land use by category (Buckeye Lake for Tomorrow, 2013)

2.2 Summary of Biological Trends for the Reservoir Feeder HUC-12

In 2008, the Ohio EPA conducted a study on the biological and water quality of the Licking River, which included Buckeye Lake's two HUC-12s. The Buckeye Lake Reservoir Feeder was determined to be Modified Warmwater Habitat and was sampled at two locations: State Route 37 (RM 1.9) and Millersport Road (RM 0.5) (Table 2). During the Ohio EPA's study it was found that the Reservoir Feeder's low gradient and wide channel width had an adverse effect on flow rate and so was functioning like a wetland instead of a riffle pool sequenced stream (Ohio EPA, 2012). Citing the unique nature of the channel, the OEPA's report notes that odd flow patterns and unknown variables may have impacted the biological assessment of the Feeder, but overall it was consistent with the habitat. In general, the OEPA rated the Feeder as Fair (QHEI x=39, n=2) but warned that "nothing about the Reservoir Feeder suggests any potential to resemble a natural stream capable of sustaining ecoregionally expected aquatic life" (Ohio EPA, 2012, pg. 15).

Year	Location	Drain. (miles^2)	IBI	MIwb	ICI	QHEI	Status
2008	RM 1.9	14.8	30	N/A	N/A	41.0	(FULL)*
	RM 0.5	18.0	29	6.5	Fair	36.0	FULL
1999	RM 0.4	18.0	36	8.4	N/A	N/A	(NON)
1984	RM 0.5	18.0	26	7.2	Fair	N/A	FULL

Table 2. Summary of biological trends for the Buckeye Lake Reservoir Feeder in 2008 (Ohio EPA, 2012).

*Use attainment status based on one organism group is parenthetically expressed.

2.3 Summary of NPS Pollution Causes and Associated Sources for the Reservoir Feeder HUC-12

The Reservoir Feeder is the primary source of external nutrient loading to Buckeye Lake (Buckeye Lake for Tomorrow, 2013). It is a relatively straight channel and is artificial in nature: it was initially hand dug and then altered over subsequent decades to fit the needs of adjacent landowners. The purpose of the channel was to divert excess water from crop fields toward the lake and to control flooding. The Reservoir Feeder drains 16.9 square miles, although the Ohio EPA estimates that only 11.9 square miles actually drain into Buckeye Lake because of diversion features near Kirkersville that convey water to the South Fork of the Licking River (Tetra Tech, 2014). Without having accurate flow data or a true depiction of the Feeder's hydrology, pollution load rates from the channel are estimates only and Tetra Tech recommends obtaining continuous flow data to better understand the Feeder's influence on Buckeye Lake. The current estimates suggest that the Reservoir Feeder contributes 23% of the total phosphorus (TP) load to Buckeye Lake annually (Tetra Tech, 2014).

There is only one notable point-source in the Reservoir Feeder watershed, the Millersport Sewage Treatment Plant. The plant has a National Pollutant Discharge Elimination System (NPDES) permit with a TP limit of 1.0 mg/l. Tetra Tech estimates that the treatment facility contributes 1.3% of the TP to Buckeye Lake annually (2014).

2.4 Additional Information for Determining Critical Areas and Developing Implementation Strategies for the Reservoir Feeder HUC-12

Even though the Feeder channel is the most important piece of this watershed, the Ohio Department of Natural Resources (ODNR) ultimately has jurisdiction over the channel itself and any projects within channel boundaries. The critical areas and implementation strategies here must take into account that only projects outside of ODNR's jurisdictional zone can be completed without ODNR's direct oversight. Filling in this gap, ODNR produced a channel study and report verification for the Feeder channel (Kirkersville Feeder Canal), which inventories the condition of the channel and notes areas of concern, such as non-functioning culverts, encroachments, depressions, embankment overtopping, and debris dams. ODNR will produce a master action plan based on the findings of this study.

Chapter 3: Conditions and Restoration Strategies for the Reservoir Feeder HUC-12 Critical Areas

3.1 Overview of Critical Areas

The critical areas identified in the Buckeye Lake Reservoir Feeder HUC-12 fundamentally address the enrichment of the waters entering Buckeye Lake by way of the Feeder's drainage. There are three critical areas in this NPS-IS: **streambank restoration** for the tributaries that discharge to the Feeder channel, failing **home sewage treatment systems**, and **agricultural land management** for parcels that drain into waterways (Figure 4). As stated previously, the Feeder channel itself is owned by the Ohio Department of Natural Resources and any associated projects must be coordinated with ODNR according to their master action plan for Buckeye Lake.

Although in the beginning stages of writing this action plan, ODNR acknowledges that project success will depend on a partnership between themselves, local conservation districts, and landowners, and they have identified four key areas of focus: Feeder repair, physical improvement, maintenance, and operational changes. In discussions with ODNR, the Department has stated their commitment to including best management practices in their plan, such as streambank stabilization for the channel, native vegetation plantings in riparian zones, and sediment traps.

3.2 Critical Area 1: Conditions, Goals & Objectives for the Reservoir Feeder Tributaries

3.2.1 Detailed Characterization

There are over a dozen tributaries in this watershed, conveying water northeast into the Feeder channel (Figure 5). Where the tributaries interface with the Feeder, soil accumulates in delta-like deposits, largely due to the impaired flow of the Feeder but also due to the structures of the tributaries themselves. Because the tributaries have been altered multiple times since the 1800s, they tend to move on their own, seeking natural pathways downslope. This movement exposes soil, contributing to greater deposits of sediment in the Feeder and downstream into Buckeye Lake. Accumulation of sediment has decreased water volume and increased nutrient loading. Lack of riparian vegetation has worsened the problem, causing further streambank erosion. In 2012, the Fairfield Soil and Water Conservation District (SWCD) identified 102 locations in the Reservoir Feeder watershed with moderate to severely eroded streambanks, accounting for roughly 10,200 feet of waterways.

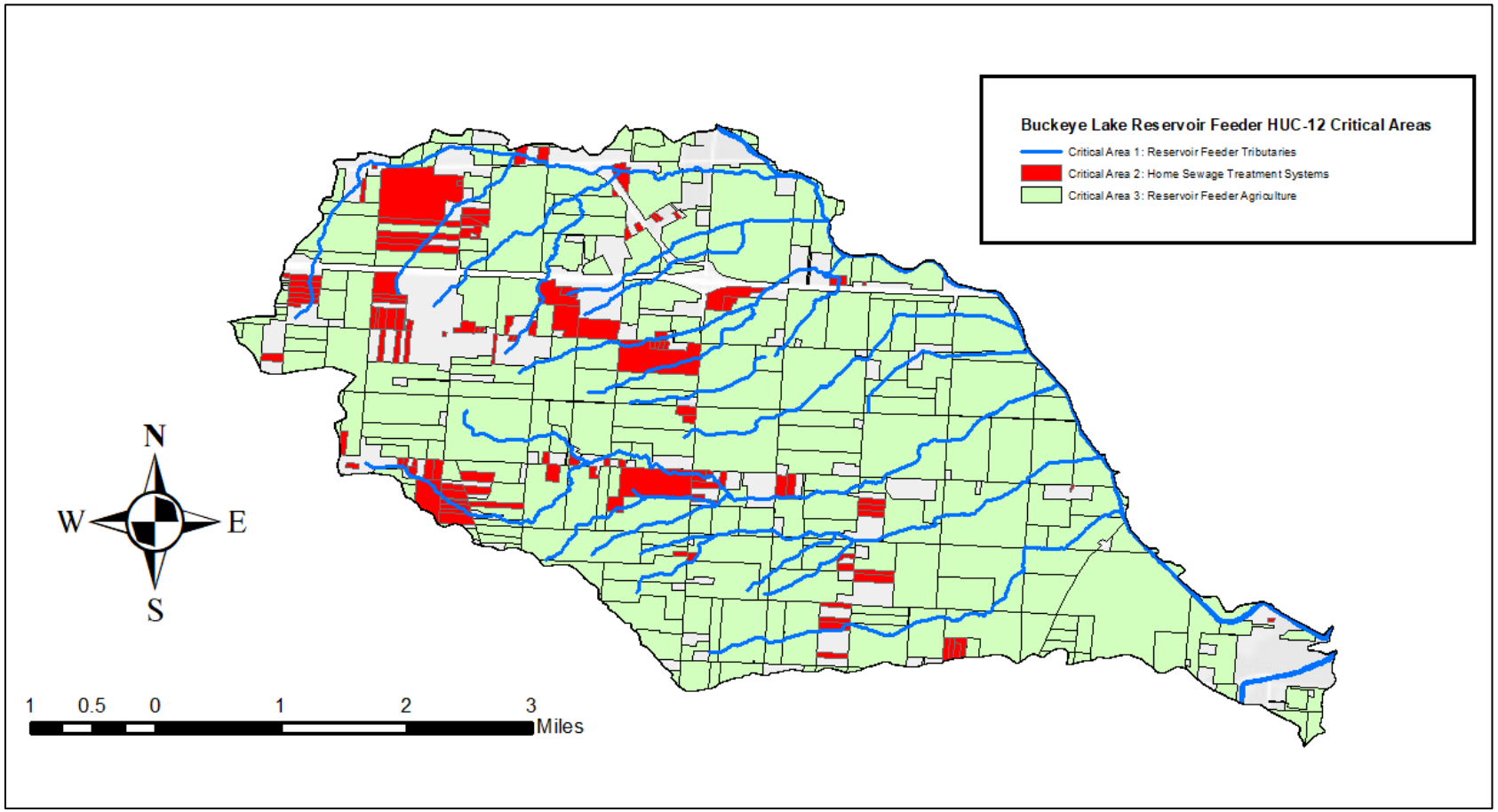

Figure 4. Buckeye Lake Reservoir Feeder HUC-12 Critical Areas Overview

Grade stabilization projects and riparian vegetation are needed to mitigate this soil loss. Channel maintenance may also be necessary in areas with high soil accumulation, such as near tributary-Feeder interfaces. Furthermore, soil removal may be warranted for existing retention ponds. There are several artificial ponds in the watershed, constructed by landowners to trap sediment. Because these ponds receive so much soil, it would be to the landowner's benefit to have them dredged periodically. It would also be to the benefit of the watershed since these ponds filter water as it moves downstream.

A secondary issue that may affect stream movement in the future is log jams. During the Fairfield SWCD's 2012 inventory, several small log jams were identified. As these jams grow large enough, they may begin redirecting water flow or causing blockages. Monitoring will be required to prevent extreme conditions. Though not eligible for 319 funding, log jam removal may indeed become a crucial element in future conservation efforts.

3.2.2 Detailed Biological Conditions

In 2008, the Ohio EPA conducted a study on the biological and water quality of the Licking River, which included the Buckeye Lake Reservoir Feeder HUC-12. Two sample sites were selected: at State Route 37 (RM 1.9) and at Millersport Road (RM 0.5). Macroinvertebrates were evaluated in a shallow flow limited reach with thick aquatic vegetation, and the fish community was assessed in a glide surrounded by corn fields (Ohio EPA, 2012).

> [The] fish assemblage was comprised by 12 species. A third (34%) were tolerant to pollution, half were omnivorous, but only a quarter (21%) were pioneering types. Larger percentages of pioneers imply instability. The substrates were not conducive to more insectivores or sensitive species. A fourth of the fish were gizzard shad. These and logperch darter were likely Buckeye Lake emigrates. The downstream fish community was typical of a lake. It included nine logperch darter, 741 gizzard shad, 47 saugeye, 34 white x striped hybrid bass, 26 yellow perch, 144 bluegill, 29 black or white crappie, and 16 largemouth bass. The absence of redhorse or other suckers and lack of minnows made for poor scores for those and the simple lithophil metrics.
>
> The macroinvertebrate community performed similarly. The EPT taxa numbers were low and tolerant taxa were numerous. Both assemblages appeared consistent with the wetland or lake environments where they resided (Ohio EPA, 2012).

Overall, QHEI was fair (x=39) and Ohio EPA indicated that the watershed is in full attainment of biological and water quality standards. However, while recommending the watershed be designated as Modified Warmwater Habitat (channel modification) aquatic life use, OEPA noted that there was little potential to sustain ecoregionally expected aquatic life (Ohio EPA, 2012).

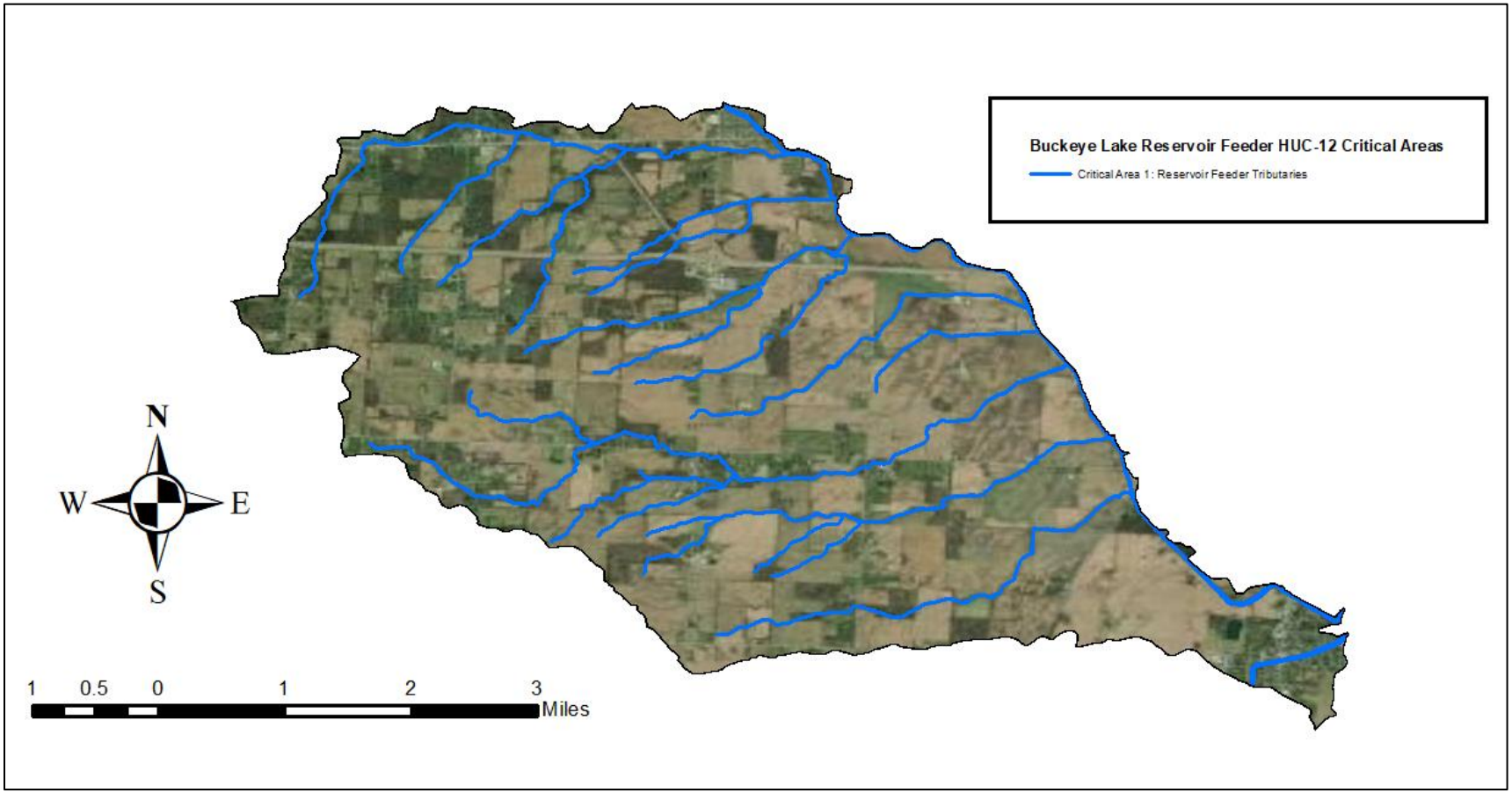

Figure 5. Critical Area 1 for the Buckeye Lake Reservoir Feeder

3.2.3 Detailed Causes and Associated Sources

The cause of impairment in Critical Area 1 is dominantly sediment accumulation. Soil lost from streambanks piles up at the tributary-Feeder interfaces and eventually runs downstream to Buckeye Lake. This increased runoff can, in turn, backwash and form thick algae-rich layers at the mouth of the Feeder. The village of Millersport is situated near this backwashed area.

Causes	*Sources*
Sedimentation	Eroded tributary streambanks
Habitat Alteration	Lack of native vegetation

Table 3. Causes and Sources for Critical Area 1

3.2.4 Outline Goals and Objectives for the Critical Area

Goals:

1. Reduce total suspended solids coming out of the Feeder channel and into Buckeye Lake from **26,992 lbs/year to 16,195 lbs/year** or less.
    - According to data from 2008-2012 EPA sampling, the Feeder channel contributes the most sediment to Buckeye Lake by a wide margin. By reducing current loads by 40%, this would yield an average of 16,195 lbs/year. A 40% reduction was chosen as a realistic goal for decreasing total loads coming out of the Feeder watershed.
2. Reduce phosphate loading by 40% from **8,839.6 lbs/year to 5,303.76 lbs/year or less** into Buckeye Lake**.**
    - A 40% reduction of P is consistent with general lake reduction goals, outlined in the 2012 Ohio Phosphorus Task Force Report and adopted by the Great Lakes Commission for Lake Erie (GLC, 2015).
3. Reduce nitrate loading by 40% from **171,488.2 lbs/year to 102,892.9 lbs/year or less** into Buckeye Lake.

Objectives:

1. Stabilize 10,200 feet of eroded streambank in the watershed.
    - From observational data obtained from the Fairfield SWCD in 2012, 102 streambank locations were identified as suffering from erosion issues, stretching across an estimated average of 100 feet per site.
2. Plant 10,200 linear feet of filter strips along eroded streambanks.
    - These same locations suffered from lack of natural riparian vegetation.
3. Establish 2,000 linear feet of floodplain
    - This would take place 500-1000 feet back from the mouth of the Feeder. Because the Feeder was so heavily excavated, it has no natural floodplain at the southeastern end, but establishing one would reduce soil loss.

3.3 Critical Area 2: Conditions, Goals & Objectives for Home Sewage Treatment Systems

3.3.1 Detailed Characterization

The Buckeye Lake Reservoir Feeder watershed has a number of households that are not connected to a centralized sewer system. These residents use a variety of home sewage treatment systems (HSTS) ranging in age from recently constructed to decades old (Figure 6). In conjunction with the county health departments, treatment systems need to be inventoried and their functionality assessed. Failing HSTS, particularly outmoded aerators, are a source of nutrient pollution. Phosphorus from wastewater can be absorbed and retained in the soil. But both unabsorbed phosphorus and nitrogen can travel in groundwater toward a water body and become a source of contamination. If there are too many leaking aerators in a small area, the nutrients flowing through the groundwater can overload a water body, causing eutrophication. There are 155 permitted aerators within the Reservoir Feeder HUC-12.

As stated in Ohio EPA's 2012 Biological and Water Quality Study of the Licking River, the "geometric mean bacteria value exceeded the PCR (Primary Contact Recreation) class B criterion (E. *coli* gmx=161 cfu/100ml)" at the downstream end of the Feeder channel. According to a recent Loading Analysis Plan for establishing TMDLs in Ohio (2020), the criterion to meet the water quality standard for Primary Contact Recreation is less than 126 cfu/100ml. So, the last reported geometric mean bacteria value is above the threshold. On a positive note, the OEPA also sampled for E.*coli* at four locations upstream, all registering below the threshold. Two samples generated cultures at 20 cfu/100ml and the other two generated cultures at 116 cfu/100ml.

3.3.2 Detailed Biological Conditions

Because the Ohio EPA conducted sampling at only two locations, representing the Buckeye Lake Reservoir Feeder HUC-12 as a whole, the Biological Conditions for Critical Area are largely the same as for Critical Area 1 in section 3.2.2.

3.3.3 Detailed Causes and Associated Sources

The cause of non-point source pollution in Critical Area 2 is E. *coli* due to nutrients attributed to human waste (EMH&T, 2016) and to a limited extent, livestock operations. There are several livestock operations in Fairfield County, as detailed in Section 3.4.1. It must be noted that manure management, an Objective for Critical Area 3, would also serve to address a source of non-point source pollution in Critical Area 2.

Causes	*Sources*
E. *coli*	Failing home sewage treatment systems, livestock

Table 4. Causes and Sources for Critical Area 2

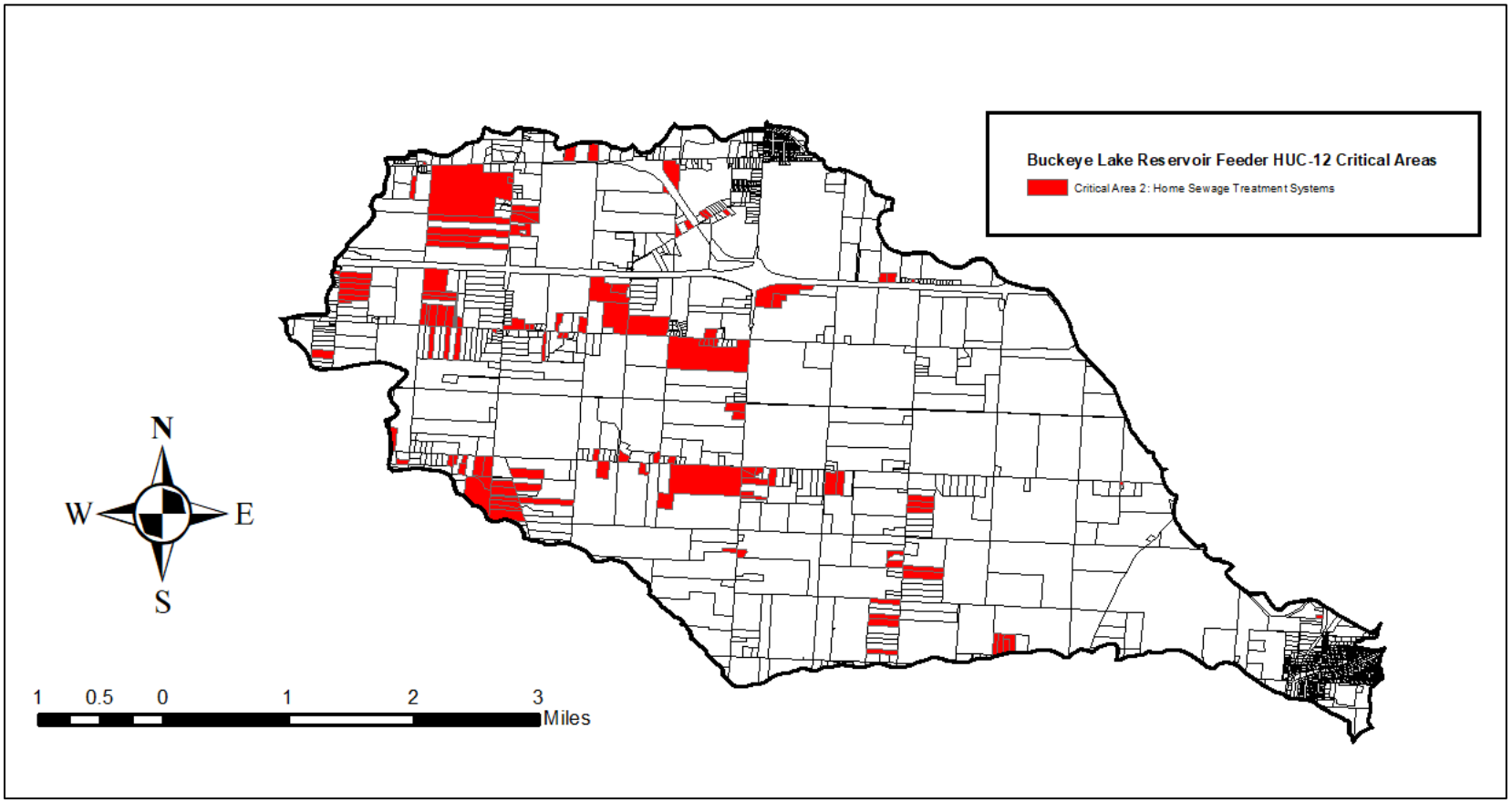

Figure 6. Critical Area 2 for the Buckeye Lake Reservoir Feeder

3.3.4 Outline Goals and Objectives for the Critical Area

Goals:

1. Reduce E. *coli* at the mouth of the Feeder to a geometric mean below the PCR criterion threshold (126 cfu/100ml). The current geometric mean exceeds the criterion threshold at 161 cfu/100ml.

Objectives:

1. Identify and upgrade at least 70 failing aerator systems in the Reservoir Feeder HUC-12.
    - In late summer 2020, the Fairfield Department of Health conducted inspections in the Buckeye Lake portion of Fairfield County. This area included both the Buckeye Lake HUC-12 and the Reservoir Feeder HUC-12.
    - 89 aerators were inspected in Fairfield County; 25 were found to be failing due to issues such as motors not running or damaged wiring. Residents were informed of these reports, and subsequent inspections found that 20 of these aerators were fixed as a result of personal notices. 5 remain failing.
    - There are 66 total aerators in the Licking County portion of the Reservoir Feeder HUC-12. A process similar to that in Fairfield County will be employed in this area. Based off of the rates of failure found in Fairfield County (~28%), it is estimated that 20 aerators are currently failing in Licking County.

As new data becomes available, these management solutions will be adapted as needed, and the previous sections will be revised in updates to this NPS-IS.

3.4 Critical Area 3: Conditions, Goals & Objectives for Reservoir Feeder Prioritized Agriculture

3.4.1 Detailed Characterization

Critical Area 3 considers agriculture in the Buckeye Lake Reservoir Feeder (Figure 7). Agriculture is the most significant land use in this watershed with 72.9% made up of row crops and pasture/hay. For the sake of clarity, agricultural production is defined here as taking place on parcels greater than 10 acres even if they are not currently in active production. Because this still covers a lot of land, the critical area is further defined as farms within 50 feet of streams and ditches, farms with 20% or more highly-erodible-land (HEL), farms that need to draw down nutrients as verified through soil testing, and farms without current nutrient management plans (Table 5). Outreach to producers will follow these priorities as a guideline.

Runoff from agricultural production is the largest source of nutrient loading to Buckeye Lake (Buckeye Lake for Tomorrow, 2013). Commercial fertilizers and to a limited extent, manure, are used to fertilize

crops, introducing high levels of nitrates and phosphates into waterways. Anywhere from 25-75% of drainage passes through sub-surface tiles and discharges directly into streams, even with grassed filter strips in place (Buckeye Lake for Tomorrow, 2013). To mitigate field runoff, solutions include installing edge of field buffers, increasing cover crops to prevent soil loss during the winter, and creating wetlands to catch and filter water before it enters the lake.

Increased buffers would also be useful in reducing nutrients from animal waste. Livestock has historically contributed minimal amounts of pollution to Buckeye Lake, and operations have increased little in the past decade. However, there is still some degree of runoff that can be reduced from existing operations. The most current livestock inventory estimate includes: 20+ chickens, 180+ cattle, 30+ horses, and 1800 hogs in the Reservoir Feeder watershed.

Rank	*Priority*
1	Row crops without a nutrient management plan
2	Row crops with verified high nutrient soils
3	Row crops within 50 feet of a waterway
4	Fields with 20% or more HEL

Table 5. Prioritized Table for Producer Outreach

3.4.2 Detailed Biological Conditions

Because the Ohio EPA conducted sampling at two locations, representing the Buckeye Lake Reservoir Feeder HUC-12 as a whole, the Biological Conditions for Critical Area are largely the same as for Critical Area 1 in section 3.2.2.

3.4.3 Detailed Causes and Sources

The cause of impairment in Critical Area 3 is dominantly nutrient pollution, though sources vary. Fertilizer runoff is just one component, as livestock also contribute a small amount of nutrients. Lack of vegetative buffers at edge-of-field also contributes to impaired stream quality, while erosion on HEL and erosion during the winter removes soil from bare fields and transports it downstream.

Causes	*Sources*
Nitrates	Row crop agriculture, livestock
Phosphates	Row crop agriculture, livestock
Habitat alteration	Lack of riparian areas and channelization
Sedimentation	Row-crop agriculture, stream bank erosion

Table 6. Causes and Sources for Critical Area 3

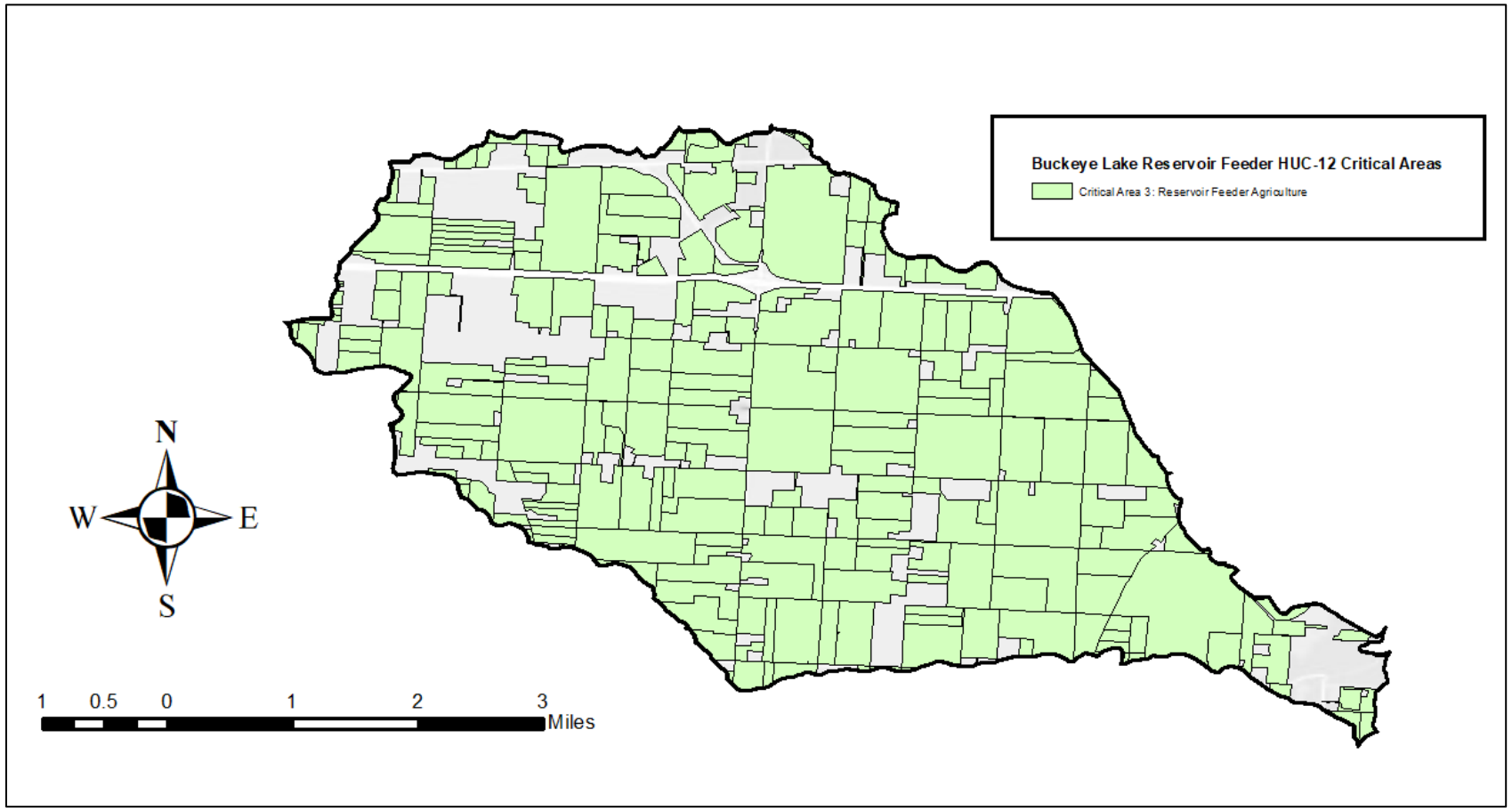

Figure 7. Critical Area 3 for the Buckeye Lake Reservoir Feeder

3.4.4 Outline Goals and Objectives for the Critical Area

Goals:

1. Reduce nitrate loading from **171,488.2 lbs/year to 102,892.9 lbs/year or less** into Buckeye Lake.
    - Data collected from Ohio EPA during 2008-2012 (Figure 8) shows that the average nitrate load coming out of the Feeder Channel was 17 kg/d/mi^2. Converted to pounds per year and multiplied by the 8,036 acres of agricultural land in the watershed yields 171,488.2 lbs/year. A 40% reduction would decrease current loads to 102,892.9 lbs/year.
2. Reduce phosphate loading from **8,839.6 lbs/year to 5,303.76 lbs/year or less** into Buckeye Lake**.**
    - Data collected from Ohio EPA during 2008-2012 (Figure 9) shows that the average phosphate load coming out of the Feeder Channel was 0.88 kg/d/mi^2. Converted to pounds per year and multiplied by the 8,036 acres of agricultural land in the watershed yields 8,839.6 lbs/year. A 40% reduction would decrease current loads to 5,303.76 lbs/year.

Objectives:

1. Enroll 1,500 acres of crop land in a nutrient management plan.
    - A nutrient management plan through NRCS will provide comprehensive guidance on best management practices, including planting native vegetation on agricultural waterways.
2. Plant 1,500 acres of cover crops annually.
    - A target of 1,500 acres of cover crops would reduce nitrate loading by 6,750 lbs/year and phosphate loading by 3,300 lbs/year.
3. Plant 1,000 linear feet of grassed waterways to repair gulleys.
    - Since there are already many producers who have adopted this BMP, these 1,000 feet will be added to already existing systems.
4. Plant 10,200 linear feet of filter strips along eroded streambanks.
    - Also identified in Objective 2 for Critical Area 1.
5. Implement manure management on 300 acres where livestock operations exist.
    - Manure management is more likely to be used by producers who import manure from outside the watershed. For livestock operations that produce manure within the watershed boundaries, there has been no real nutrient excess but there could be in the future.

As new data becomes available, these management solutions will be adapted as needed, and the previous sections will be revised in updates to this NPS-IS.

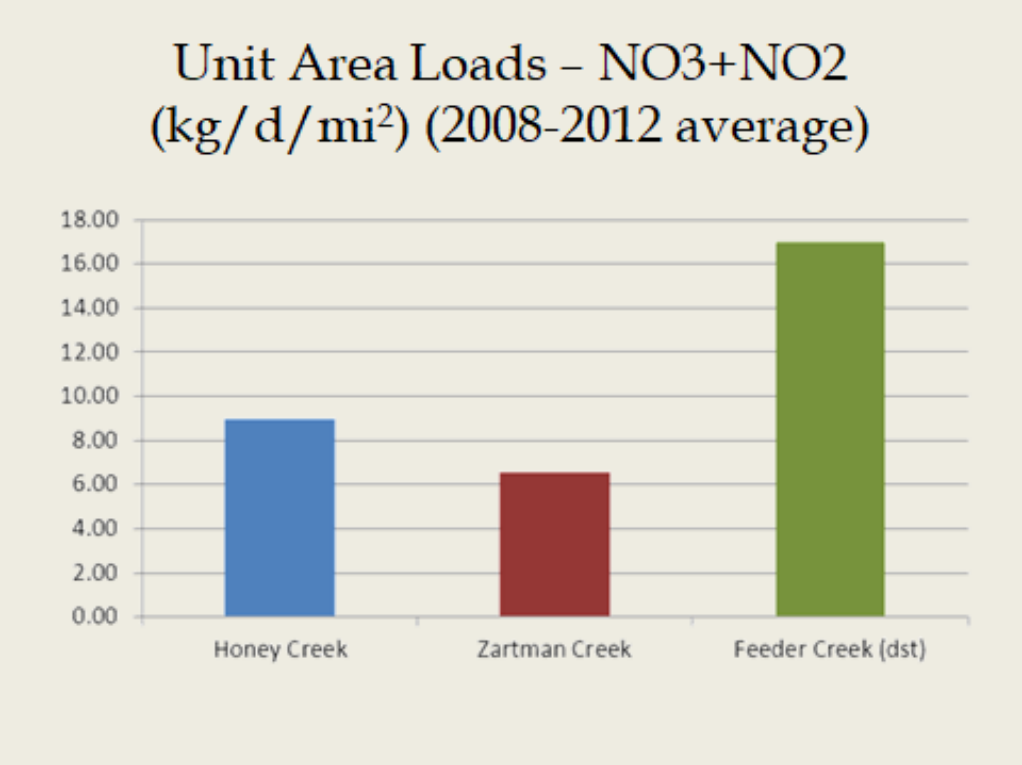

Figure 8. Nitrate loads from the Feeder Channel (EPA Data)

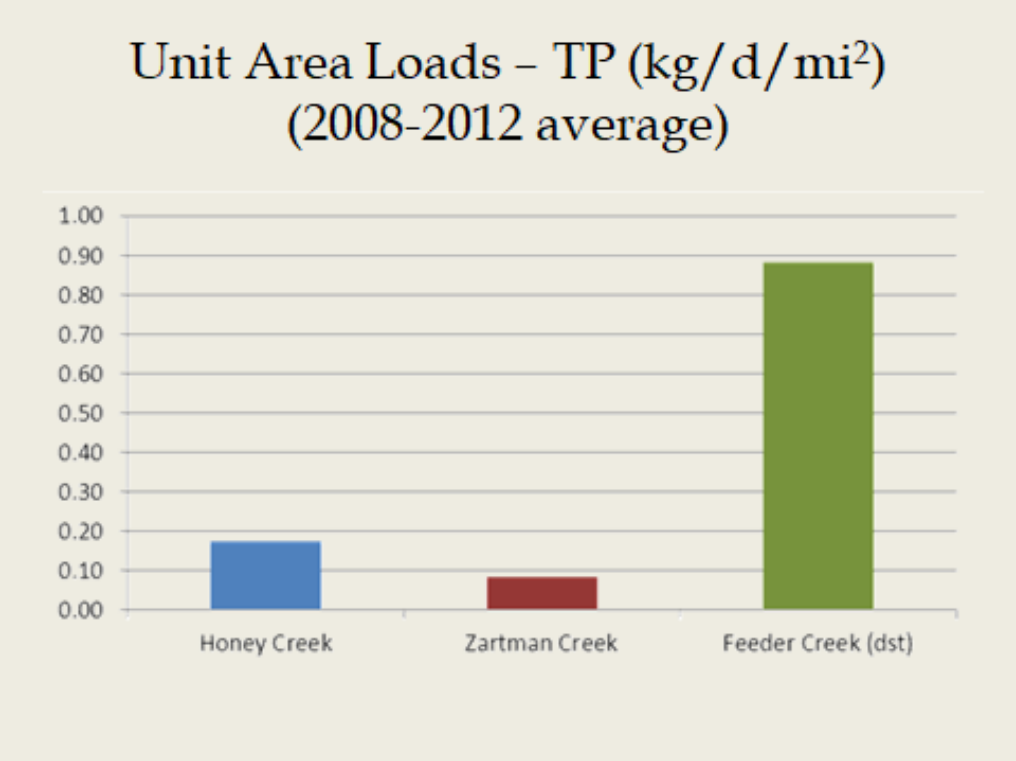

Figure 9. Phosphate loads from the Feeder Channel (EPA Data)

Chapter 4: Projects and Implementation

Overview Table and Project Sheets for Critical Areas

The next table shows the planned projects and evaluation strategies for removing impairments in the Buckeye Lake Reservoir Feeder HUC-12. Periodic re-evaluation will be necessary to assess the impact of the implementation projects. Any causes of impairment other than nonpoint source pollution will need to be addressed under different initiatives, authorities or programs which may or may not be accomplished by the same implementers addressing the nonpoint source pollution issues.

For the Buckeye Lake Reservoir Feeder HUC-12, there is one *Projects and Implementation Strategy Overview Table*, representing the critical areas listed above. Any nonpoint source impairments identified for one of the existing critical areas in the future will be added to the table. Priority is given to projects that specifically address the *Objectives* for a Critical Area, as listed in Chapter 3, projects where land-owner engagement makes the process of addressing impairment feasible, and projects that promote education among the public.

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

4.1 Overview Table for Critical Areas 1-3

For Buckeye Lake Reservoir Feeder (HUC 12) (05040006 04 04)								
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								
2	1	1	1	HSTS Replacements or Upgrades	County Health Departments	Short	$25,000	Local Sources, H2Ohio
Altered Stream and Habitat Restoration Strategies								
1	1, 2, 3	1	2	Streambank Stabilization	NRCS, SWCDs	Medium	$160,000	EPA 319, USDA-NRCS
1	1, 2, 3	2	3	Filter Strips	NRCS, SWCDs	Medium	$5,000	EPA 319, USDA-NRCS, H2Ohio
Agricultural Nonpoint Source Reduction Strategies								
3	1,2	1	4	Nutrient Management Plans	NRCS, SWCDs	Medium	$70,000	H2Ohio, USDA-NRCS
3	1, 2	3	5	Grassed Waterways	NRCS, SWCDs	Medium	$5,000	EPA 319, USDA-NRCS
3	1,2	2	6	Cover Crop Program	SWCDs	Ongoing	$45,000, annually	USDA-NRCS, MWCD, H2Ohio

Table 7. Critical Area Project Overview

4.2 Project Summary Sheets

Critical Area 1: Project 1		
Nine Element Criteria	**Information needed**	**Explanation**
n/a	**Title**	**HSTS Replacements or Upgrades**
criteria d	**Project Lead Organization & Partners**	Fairfield and Licking SWCDs Fairfield Department of Health, Licking County Health Department
criteria c	**HUC-12 and Critical Area**	Buckeye Lake Reservoir Feeder HUC-12 Critical Area 2: Home Sewage Treatment Systems
criteria c	**Location of Project**	Buckeye Lake Reservoir Feeder HUC-12 On parcels containing an aerator system
n/a	**Which strategy is being addressed by this project?**	Urban Sediment and Nutrient Reduction Strategies
criteria f	**Time Frame**	Short (1-3 Years)
criteria	**Short Description**	Failing aerators contributes to E.*coli* levels in the watershed. Updating or replacing aerator units will prevent this source of nutrients from seeping into waterways.
criteria g	**Project Narrative**	There are 155 permitted aerator systems in the Buckeye Lake Reservoir Feeder HUC-12. Because many aerators are out-of-date or are not being maintained, they leak waste water, introducing a preventable source of nutrients into the watershed. This raises E.*coli* levels. With the support of the county health departments and funds obtainable through local sources, aerator systems will be inspected for signs of failure, and system owners will be notified if their tank is in need of repair. The process is already underway in Fairfield County, and a similar method will be employed in Licking County. $5,000 from the Fairfield County Commissioners were granted to the Fairfield SWCD to fund the inspections that took place in late summer 2020 in collaboration with the Fairfield Department of Health. It is likely that re-inspection will need to take place, especially as more units fail. So, this project estimates that another couple inspection rounds will take place in Fairfield County over the next few years, in addition to the inspections that will occur in Licking County.
criteria d	**Estimated Total Cost**	$25,000
criteria d	**Possible Funding Source**	Local Sources (county commissioners, health departments), H2Ohio
criteria a	**Identified Causes and Sources**	Cause: E. *coli* Source: Failing home sewage treatment systems

criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	The goal of Critical Area 2 is to bring E.coli levels below recreational water quality limits (<126 cfu/100ml). To remove home sewage treatment systems as an impairment, all outdated aerators in the watershed will eventually need to be replaced with updated models. A process and schedule for inspection will also need to be designed to ensure that new models continue to work as intended.
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	In this project's current iteration, in which 28 of the 155 aerators are expected to be failing (20 in Licking County and 5 remaining in Fairfield County), 29% of the critical area will be addressed if these aerators are fixed. 20 leaking aerators have already been addressed in Fairfield County. In the future, once all aerators have been updated, the critical area will be fully addressed.
	Part 3: Load Reduced?	This project has little impact on load reductions, but fixing the currently failing aerators is estimated to drop E. *coli* by 15-30% at the mouth of the Feeder.
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	ODNR conducts bi-weekly E.*coli* sampling on Buckeye Lake during the summer. Concentrations will be measured and compared to past results. Additionally, the county health departments will continue doing routine inspections of home sewage treatment systems.
criteria e	**Information and Education**	The project will be promoted to producers and other stakeholders with news releases, social media, and personal contacts from the SWCDs and the county health departments.

Works Cited

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Great Lakes Commission. (2015). Lake Erie Nutrient Reduction Plan Released. www.glc.org/news/2015-lake-erie-nutrient-reduction-plan-released/

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Ohio EPA. (2020). Loading Analysis Plan and Supporting Data Acquisition Needed for Recreation/E. *coli* TMDLs in Selected Watershed Around the State of Ohio. Columbus: Ohio EPA.

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Tetra Tech. (2020). Kirkersville Feeder Canal Study and Report Verification. Prepared for the Ohio Department of Natural Resources.

Appendices

Appendix A: Acronyms and Abbreviations

The acronyms and abbreviations listed below are either common among organizations working to restore Ohio's watershed or were created for this NPS-IS plan.

B	
BLT	Buckeye Lake for Tomorrow
BMP	Best Management Practice
C	
COD	Chemical Oxygen Demand
CFU	Colony-forming unit
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
D	
DO	Dissolved Oxygen
E	
EQIP	Environmental Quality Incentives Program
EWH	Exceptional Warmwater Habitat
F	
FSA	Farm Service Agency
H	
HABs	Harmful Algal Blooms
HEL	Highly Erodible Land
HSTS	Home Sewage Treatment Systems
HUC	Hydrologic Unit Code
I	
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index

M

Mg/L	Milligram per Liter
MIwb	Modified Index of Well Being
MWCD	Muskingum Watershed Conservancy District
MWH	Modified Warmwater Habitat

N

N	Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NPS-IS	Nonpoint Source Implementation Strategy
NRCS	Natural Resources Conservation Service

O

ODA	Ohio Department of Agriculture
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency

P

P	Phosphorus
PCR	Primary Contact Recreation
PNMP	Precision Nutrient Management Plan

Q

QHEI	Qualitative Habitat Evaluation Index

R

RM	River Mile

S

SLWCD	South Licking Watershed Conservancy District
SWCD	Soil and Water Conservation District

T

TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load Limits
TP	Total Phosphorus

U

µg/L	Micrograms per Liter
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

W

WWH	Warmwater Habitat
WWR	Waste Weir Run
WWTP	Wastewater Treatment Plant

Appendix B: Index of Tables and Figures

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Index of Tables