Watershed Action Plan

Raccoon Creek Headwaters to above Hewett Fork Watershed

2007

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Executive Summary

The purpose of the Raccoon Creek Headwaters Management Plan is to maintain, improve, and restore the chemical, physical and biological integrity of the watershed. This is the objective put forth by the Clean Water Act of 1972. This plan is based on the outline provided in the Appendix 8 update to "A guide to Developing Local Watershed Action Plans in Ohio". This plan also satisfies a requirement of the Ohio Department of Natural Resources' Watershed Coordinator grant.

The Raccoon Creek Headwaters Management Plan has been produced to document the restoration projects that have been completed or are currently underway, establish or monitor watershed baseline conditions, and identify restoration project needs and action plans in the watershed. Action plans are provided at the 14-digit hydrologic unit code (HUC) scale. This Plan is the first in a series of five plans that will cover the entire Raccoon Creek watershed, the series is scheduled for completion by 2009.

The organization of this plan includes two sections. The first provides a watershed overview for the 11-digit HUC section, the Raccoon Creek Headwaters to above Hewett Fork, the second section is dedicated to action plans for each of the seven 14-digit HUC subwatersheds therein.

Much of the information provided in this Plan was first compiled in the *Raccoon Creek Management Plan: A collaboration of Raccoon Creek partners and community members of the Raccoon Creek watershed,* produced in 2003 by the Institute for Local Government Administration and Rural Development (ILGARD) at Ohio University. The 2003 Plan approach considered the entire watershed.

This management plan was authored under the premise of *adaptive management* which suggests that future management planning will evolve based on the findings and recommendations of this Plan. Watershed conditions experience constant change and this Plan attempts to identify priority projects for the next five to ten years.

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This Plan contains information and data from several agencies or organizations either through published reports or from agency records:

- Ohio Department of Natural Resources - Division of Mineral Resources Management
- Ohio Department of Natural Resources – Division of Soil and Water Conservation
- Ohio Department of Natural Resources – Division of Fish and Wildlife
- Ohio Department of Natural Resources – Division of Natural Areas and Preserves
- Ohio Environmental Protection Agency
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- United States Geological Survey
- United States Forest Service – Wayne National Forest
- Vinton County Soil and Water Conservation District
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TABLE OF CONTENTS

List of Tables

List of Figures

Appendices

List of Maps

SECTION I.

WATERSHED OVERVIEW

FOR

RACCOON CREEK
HEADWATERS TO ABOVE HEWETT FORK WATERSHED

Watershed Description

Introduction

The Raccoon Creek watershed begins at the southern boundary of Hocking County and generally flows south until it enters the Ohio River in Gallia County, south of Gallipolis (Map 1). Raccoon Creek is 112 miles in total length and the watershed covers an area of approximately 683 square miles. The watershed lies within portions of six counties: Hocking, Vinton, Athens, Meigs, Jackson, and Gallia. This Raccoon Creek comprehensive watershed management plan addresses water quality in one portion of the overall watershed, the "Raccoon Creek Headwaters to above Hewett Fork" sub-watershed, Hydrologic Unit Code (HUC) 05090101-020.

For planning and assessment purposes watersheds throughout the nation are given a hydrologic unit code (HUC) by the US Water Resources Council. This classification system organizes watersheds and sub-watersheds into increasingly smaller units as the code increases in digits. The Raccoon Creek watershed has been divided up into five separate 11-digit hydrologic units (HUCs), or sub-watersheds (Table 1).

Table 1. Raccoon Creek Watershed 11 -Digit HUC Watersheds

11-Digit HUC	Name	Acres
05090101-020	Raccoon Creek (headwaters to above Hewett Fork)	86,714
05090101-030	Raccoon Creek (above Hewett Fork to below Elk Fork)	99,233
05090101-040	Raccoon Creek (below Elk Fork to above Little Raccoon Creek)	60,789
05090101-050	Little Raccoon Creek	98,927
05090101-060	Raccoon Creek (below Little Raccoon Creek to Ohio River)	90,081

Within each 11-digit HUC watershed, subwatersheds are delineated into 14-digit HUC watersheds. The 14-digit HUC watershed is the smallest defined watershed unit. In the Raccoon Creek Headwaters there are seven 14-digit HUC watersheds (Map 2, Table 2). Data collection and planning for watershed restoration and protection is done at the 14-digit HUC level in this watershed action plan.

The "Raccoon Creek Headwaters to above Hewett Fork", otherwise known as the Raccoon Creek Headwaters from here on, drains 137 square miles or 86,714 acres and is located in both Vinton and Hocking Counties (Map 3). In Hocking County, the Headwaters are located in portions of Starr and Washington townships. In Vinton

County, the Headwaters are located in portions of Jackson, Swan, Brown, Elk, Madison and Knox townships.

Table 2. Raccoon Creek Headwaters 14-digit HUC Watersheds

14-Digit HUC	Name	Acres
05090101-020-010	East Branch Raccoon Creek above West Branch	12,768
05090101-020-020	West Branch Raccoon Creek above East Branch	14,542
05090101-020-030	Raccoon Creek below West Branch to above Brushy Fork.	10,417
05090101-020-040	Brushy Fork (i.e. Brushy Creek)	21,633
05090101-020-050	Wheelabout Creek	7,612
05090101-020-060	Raccoon Creek below Brushy Fork to above Hewett Fork. [except Wheelabout Creek and Sandy Run]	12,414
05090101-020-070	Sandy Run	7,366

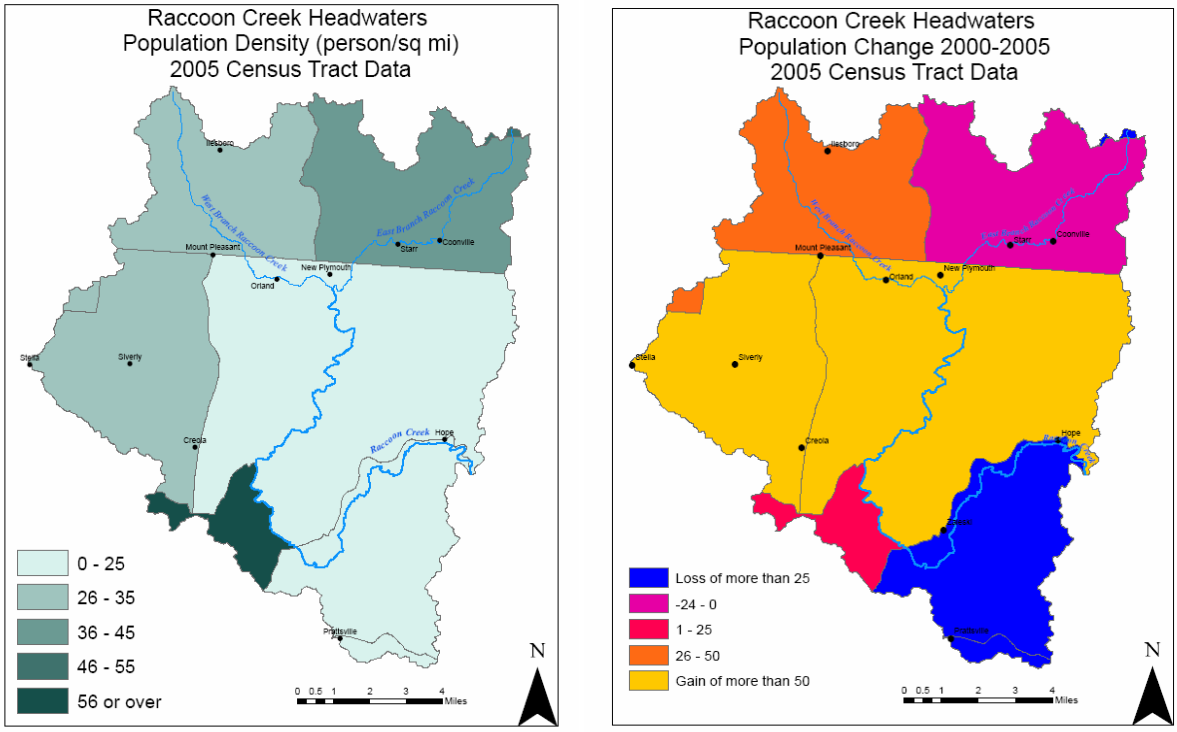
Raccoon Creek begins just south of the village of New Plymouth where the East and West Branch converge in northern Vinton County. The headwaters section flows mostly in a south-southeast direction except for a four mile section where it makes a large turn and flows north from the Zaleski State Forest to Lake Hope State Park. The watershed is very rural with the village of Zaleski being the only incorporated population center in the sub-watershed. Other small unincorporated towns include Mount Pleasant, Orland, New Plymouth, Starr, Coonville, Siverly, Creola, Hope, Red Diamond, Vinton, and Prattsville. Ohio EPA Phase II Stormwater regulations do not apply to the aforementioned communities because they are below the established population requirements for those regulations. The Raccoon Creek Headwaters watershed contains large public land holdings that attract tourists from around the state for recreational activities including hunting, hiking, mountain biking, backpacking, horseback riding, camping, bird watching, canoeing, kayaking, fishing and many other recreational pursuits. Public lands include Lake Hope State Park, which occupies 2,983 acres totally within the Raccoon Creek Headwaters. Zaleski State Forest (26,827 acres) and the Waterloo Wildlife Area (2,635 acres) also lie partially within the watershed. The Wayne National Forest – Athens District does have land holdings that extend southward into the watershed, mostly Hocking County (East Branch) with a small portion in Vinton County (Brushy Creek).

Demographics and Economic Information

The demographic information and trends in this plan were measured using Geographic Information System (GIS) data and U.S. census data from 2000 and 2005. The general synopsis is that the Headwaters of Raccoon Creek are very sparsely populated (Figure 1). Through a GIS analysis of the United States Census data for 2000 and 2005, a detailed description of the Headwaters emerges. The area is comprised of a large portion of northern Vinton County and a smaller area inside southern Hocking County. This is one of the least populous areas of Ohio and is the least populated and most remote area in the entire Raccoon Creek Watershed. Zaleski is the largest populated place in the area with

375 residents in 2000. The population density of the Raccoon Creek Headwaters in 2005 was 32 people per square mile. For comparison, the entire Raccoon Creek watershed's population density in 2005 was 263 people per square mile. According to US Census data, the Raccoon Creek Headwaters did not experience significant growth between the years 2000 and 2005. In 2000 the population of the headwaters area was 9,819 and grew to 10,029 over the next five years. This translates to a population change of around 2.1%. For the same time period the entire watershed grew from 65,810 residents to 66,532, a positive change of 1.1%.

Figure 1. Raccoon Creek Headwaters Population Analysis



The median age in the Headwaters area is 37.2 years of age which is slightly higher than that of the entire watershed which is 36. The average household size is 2.63 persons for the Headwaters, compared with 2.58 for the entire watershed. The per capita income for the Headwaters is $14,305, far below the $21,003 average for the state of Ohio. The only active industry located directly in the Raccoon Creek Headwaters is Austin Powder near McArthur. Austin Powder produces explosives that are mainly used in mining operations throughout the region.

Ohio economic data from 1999 reveals relatively low incomes and a higher percentage of residents below the poverty level in comparison to state averages. The percentage of watershed residents who live below the poverty rate in Vinton County is 20% and 13.5% of residents in Hocking County, compared to the overall state average of 11%.

Special districts and organizations that serve the Hocking County section of the Headwaters include the Hocking County Soil and Water Conservation District, the Buckeye Hills-Hocking Valley Regional Development District, the Hocking County Cooperative Extension Service, and the Hocking County Regional Planning Office. The Athens County USDA Farm Service Agency covers Hocking County.

Special districts and organizations that offer services to the Vinton County section of the Headwaters include the Vinton County Development Department, the Vinton County Emergency Management Agency, and the Vinton County Soil and Water Conservation District. The Ohio Valley Regional Development Commission (OVRDC) also serves Vinton County. Jackson County's USDA Farm Service Agency provides services to Vinton County. The Ohio EPA maintains its southeast District office in Hocking County which serves the southeastern region of Ohio.

Watershed Plan Development

Watershed planning and restoration activities have been underway in the Raccoon Creek watershed since the mid 1980's with the formation of the Raccoon Creek Improvement Committee (RCIC) (Figure 2). The first management plan was initiated by the RCIC and developed for the Little Raccoon Creek watershed in the mid 1990's by several partnering state agencies.

Watershed coordination began in 1996 with an U.S. EPA Clean Water Act section 319 grant. A project manager was hired and based at the Vinton Soil and Water Conservation District at that time. Since 1996, a Raccoon Creek projects manager has been at the Vinton SWCD coordinating and implementing AMD water quality improvement projects. In 2000 the Voinovich School of Leadership and Public Affairs at Ohio University partnered with OEPA, ODNR Division of Mineral Resources Management, OSU Extension, and the Ohio Coastal Management Program and was awarded the ODNR Division of Soil and Water Conservation Watershed Coordinator Grant. This program provides an opportunity for organizations and agencies to plan and implement water quality improvement programs on a watershed basis by supporting the Coordinator's position. The Voinovich School has been a partner and sponsor in this program since 2000 and has supported the employment of the Raccoon Creek Watershed Coordinator. A second Watershed Coordinator grant was awarded in 2006 and will continue through 2009.

A comprehensive Raccoon Creek Management Plan was developed in 2003 (ILGARD, 2003) that dealt with water quality issues throughout the entire watershed. This 2003 plan was created through a collaboration of Raccoon Creek partners and community members and received conditional endorsement by the Ohio EPA and ODNR. The 2003 plan took an overall approach to watershed planning and restoration and was a highly involved community effort created with a methodology based on community input and participation. The 2003 plan did follow state guidance using the "Guide to Developing Watershed Action Plans in Ohio" but did not include specific restoration or protection

activities on the 14-digit HUC watershed scale as described later in the Appendix 8 update after the plan was completed.

This edition, The Raccoon Creek Headwaters Management Plan, is based on activities to promote water quality restoration & protection efforts at the 11-digit HUC scale. This plan is the first in a series of plans that will be addressing all five 11-digit HUC sub-watersheds in the entire Raccoon Creek watershed.

Planning efforts and studies related to water quality in the Raccoon Creek watershed are numerous and include the efforts of several Raccoon Creek watershed partners. An Acid Mine Drainage Abatement and Treatment (AMDAT) plan for the Raccoon Creek Headwaters was developed in 2002 (Rice, 2002). It should be noted that the Raccoon Creek Headwaters AMDAT covers more watershed area than the 11-digit HUC watershed scale of this management plan. The AMDAT addresses additional drainages south to SR 50 at Bolins Mills, which includes Hewett Fork.

Ohio EPA completed a Total Maximum Daily Load (TMDL) study in 2002 for the Upper Basin of Raccoon Creek (which includes three 11-digit HUC watersheds: Raccoon Creek Headwaters, Raccoon Creek above Hewett Fork to above Elk Fork, and Raccoon Creek above Elk Fork to above Little Raccoon Creek). The Ohio EPA TMDL set targets for acid mine drainage parameters such as net-alkalinity and dissolved metal concentrations.

In 2007, a sediment TMDL was developed by Ohio University's Voinovich School of Leadership and Public Affairs for the Upper Basin of Raccoon Creek (McCament, 2007). This TMDL study established targets for habitat and channel stability.

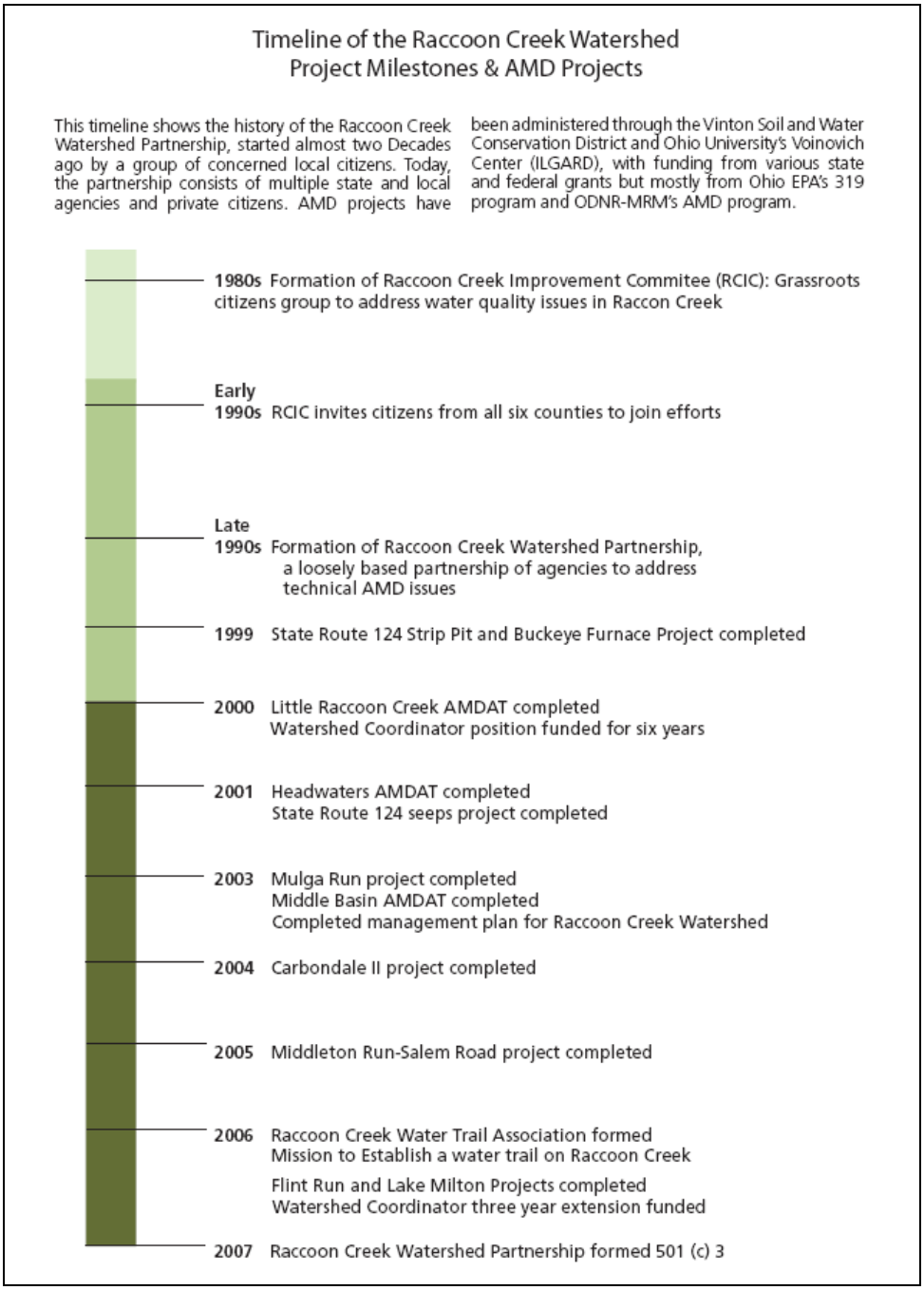
Watershed Partners

The Raccoon Creek watershed project has operated as a collaborative group of organizations, individuals, and agencies for over a decade with a goal of improving water quality in Raccoon Creek. Partnering groups and agencies have been essential in accomplishing a broad range of Raccoon Creek goals including education, public outreach, stream monitoring, and water quality improvement projects. Many of the agencies and organizations that have contributed to the watershed project over the past decade are listed in Appendix 1.

Through various planning and fundraising efforts it became apparent that there was a need for the watershed project to formalize its structure and become a member-based organization. In 2007, the Raccoon Creek Partnership (RCP) was formed and was granted incorporation status by the state of Ohio. The RCP established bylaws and received 501(c) 3 status from the IRS in October of 2007. The mission of the RCP is "to work toward conservation, stewardship, and the restoration of the watershed for a healthier stream and community". Representation from individuals, landowners, Ohio EPA, ODNR-DMRM, Ohio University's Voinovich School of Leadership and Public Affairs, and the Vinton County Soil and Water Conservation District sit on the RCP's interim Board. In October of 2007, the RCP held its first election to replace the interim

Board of Directors with elected Directors. The bylaws state that the nature of the organization "is formed as a partnership of individuals, businesses, agencies, organizations, institutions, corporations, and governmental units with the common mission and purpose of the Raccoon Creek Partnership".

Figure 2. Raccoon Planning and Implementation Timeline



The RCP's established bylaws (Appendix 2) outline the purpose, membership levels, the Board of Directors offices and duties, various committees within the Board of Directors, financial provisions, quorum stipulations, amendment procedures, indemnification, and dissolution processes. The bylaws set up a shared governance system that incorporates participation from agencies, organizations, and individuals who want to contribute to the partnership. Currently, the RCP is building relationship with important stakeholders and establishing a membership base.

Watershed partners and stakeholders in the Raccoon Creek Headwaters specifically include any and all individuals and entities that will be affected by this plan. This includes: local and state agencies, county commissioners and other local government officials, educational institutions, citizens groups, and non-governmental organizations. Land owners in the watershed are also critical partners for restoring and protecting water quality and habitat in the Raccoon Creek Headwaters. Since a large portion of land ownership in the Raccoon Creek Headwaters is public, the U.S. Forest Service and the Ohio Department of Natural Resources (Divisions of State Parks, Wildlife, and Forestry) are essential partners. Other key stakeholders in the Raccoon Creek Headwaters include:

- The Raccoon Creek Water Trails Association: In 2005, a group of local citizens interested in recreation and stewardship of Raccoon Creek joined to form the Raccoon Creek Water Trails Association (RCWTA). The group is composed of paddlers, watershed advocates, biologists, and outdoor recreation professionals and enthusiasts working towards state water trail designation. The RCWTA is currently working an inventory of launch sites for Raccoon Creek from river mile 100 to the confluence with the Ohio River. The mission of the RCWTA "is to encourage stewardship, environmentally responsible recreation, and economic and scenic opportunities in the Raccoon Creek Watershed. We seek to promote natural and cultural resources through public access and education". www.raccooncreekwatertrail.org

- The Moonville Rail Trail Association (MRTA) began in 2001 and works to establish, maintain and promote a recreational trail system with emphasis on the use of former rail lines and connecting corridors. The MRTA is a non-profit organization that preserves local history and the environment, provides educational opportunities for trail design, use, and maintenance, assists the surrounding communities in promoting education, tourism, and economic development and creates an awareness of the needs of different "muscle-powered" user groups. The MRTA has various volunteer committees such as: public relations and fundraising, a trail committee, and a grant committee. The MRTA holds regularly scheduled public meetings at the Hope School House, near Lake Hope.

- The Friends of Lake Hope (FLH) formed in 2006 and membership includes local residents, park visitors, employees, and others interested in Lake Hope. The FLH is dedicated to improving the Lake Hope State Park and adjacent areas. The FLH mission is "to foster a partnership between the public and

Lake Hope State park to enhance, preserve, protect, and promote Lake Hope State Park for present and future generations". Projects and interests include various public outreach events, maintenance of the grounds, and educational efforts.

Additional stakeholders operating in the Raccoon Creek Headwaters include the Ohio Outback Conservation Corps, an AmeriCorps program of Sojourners headquartered in McArthur; the Vinton County Agriculture Society or Vinton County Fair Board; the Ohio Valley Resource Conservation and Development (RC&D) Council serving Vinton County; the Tri-County (Hocking-Athens-Perry) Community Action Agency; and the Corporation for Ohio Appalachian Development (COAD). Educational institutions include Ohio University and Hocking College which both serve the region. OSU Extension has offices in both Hocking and Vinton Counties.

General Plan Contents

This watershed management plan document has been produced to address the key concepts suggested in "A Guide to Developing Local Watershed Action Plans in Ohio". The plan's organization is based on the Appendix 8 Update to that guide. This plan is designed to identify problem areas and provide action recommendations to achieve water quality improvement and protection.

This plan includes information and data from the original management plan which took an overall approach to the watershed, as well as new information and data drawn from a variety of sources which is attributed to 11-digit and 14-digit hydrologic unit codes (HUC) watersheds.

Educational efforts are critical to successfully implementing this plan and other watershed objectives. The Raccoon Creek Partnership (RCP) is the entity that will work with local residents, agencies, and organizations to implement management practices outline in this plan to improve water quality in Raccoon Creek. RCP educational efforts are listed on www.raccooncreek.org and include public meetings, an aquatic education center at Waterloo, school programs, and more. The RCP has a 7 member board of directors and a Technical Advisory Committee that meets quarterly to work on water quality issues and projects. This management plan will be submitted to the OEPA and the ODNR for approval. Upon receiving approval from those agencies the plan will be presented to local the RCP and the Vinton and Hocking Soil and Water Conservation Districts for endorsement. See Appendix I for "Endorsement Page"

Watershed Description

Land Use

Land use is a dominant factor in determining the overall condition of a watershed. The following section presents a summary of land use in the Headwaters based on 2001 Landsat data provided by Ohio Department of Natural Resources.

The dominant land cover in the entire Raccoon Creek watershed is forest, comprising 80% of the land base. Deciduous hardwoods account for 75% of this forest land use. Agricultural land makes up only 13% of the watershed, with only 4% in row crops and 9% in pasture and hay. The only other significant land type is low intensity residential which accounts for less than 6% of the land base. Land use/land cover for the Raccoon Creek Headwaters 11-digit HUC watershed shows similar patterns with approximately 79% forested (Map 4, Table 3). Farmland accounts for about 12% of total land cover while developed areas account for about 5.7%.

Table 3. Land Cover in the Raccoon Creek Headwaters Watershed
(Source: USGS, 2001 National Land Cover Database)

Land Cover Category	Acres	Percentage
Open Water	284.22	0.33
Developed, Open Space	4840.63	5.58
Developed, Low Intensity	178.14	0.21
Developed, Medium Intensity	7.56	0.01
Barren Land (Rock/Sand/Clay	128.10	0.15
Deciduous Forest	64996.63	74.99
Evergreen Forest	3756.68	4.33
Mixed Forest	12.90	0.01
Shrub/Scrub	253.97	0.29
Grassland/Herbaceous	356.05	0.41
Pasture/Hay	8208.78	9.47
Cultivated Crops	3564.97	4.11
Forested Wetlands	57.38	0.07
Emergent Herbaceous Wetlands	30.02	0.03
Total	**86,676**	**100**

A few trends are apparent when comparing land use/land cover data from 1994 to 2001. Deciduous forest increased by over 4,000 acres, a 5%. This results in a total increase of forested land in the watershed of 75% to almost 80% in 2001. Agricultural land uses showed corresponding decreases with hay/pasture decreasing by approximately 7,000 acres and cultivated crops decreasing by 1,100 acres (8.5 and 1.3% respectively). Wetland areas also decreased by 247 acres according to the Landsat data, which is a 50% decrease. This data does not correspond with the Ohio Wetland inventory data set however, which documents twice the amount than the Landsat data indicates (170 acres vs 87 acres).

The current and recent land use/cover is not always telling of past land uses. Raccoon Creek and its tributaries have been subjected to series of land use changes over the past two centuries. The first forest clearing began in the early 1800's for agriculture with the first European settlers moving into the region. By the mid 1800's the iron furnace industry had taken hold which led to wide scale deforestation. Remnants of the Hope Furnace, located at Lake Hope State Park, are still present and serve as a landmark to a vastly different landscape in the later 1800's in the area. Each iron furnace is believed to have cleared a five square mile area around it for timber to make charcoal for the furnace. Coal mining began in the watershed in the late 1800's with small underground room and pillar mines, which also required large amounts of timber for roof supports and train tracks. Coal mining led to boom towns in the watershed. These towns reached peak populations levels in the early 1900's and exist today (if at all) as a small relic of the area's industrial past. Reforestation began in the region in earnest with the Great Depression where many family farms were abandoned and left fallow. In addition, federal and state governments began buying up land and allowing reforestation to occur.

Cultural Resources

Documented human history in the watershed began with the Adena Native American tribe. The Hopewell, Shawnee and Delaware groups followed. European influences began to appear in the 1740's. In 1795, the Delaware, Shawnee and several other Native American tribes signed the Treaty of Greenville ending the Northwest Indian War and relinquishing Native American land rights throughout the region.

In 1849, the Scioto and Hocking Valley Railroad began. By 1856, the main line of the Marietta and Cincinnati Railroad was complete, resulting in the establishment of Zaleski as a prospering railroad town from the mid-1860's to 1890's. By the 1880's, rail

Figure 3. Picture of Moonville Tunnel

lines had reached McArthur and stimulated growth there as well. From the 1880's to the 1970's rail lines were the primary transportation for coal in the region until trucking and highways were established.

Points of Interest in the Raccoon Creek Headwaters Include:

- Ceremonial Mounds: Several mounds lie in the Lake Hope-Zaleski area and are attributed to the Adena people.
- Cox Covered Bridge: Constructed in 1884, Cox Covered Bridge spans Brushy Creek. Cars can no longer drive through the bridge.
- Hope Furnace: This area contained the necessary materials to produce iron-limestone, iron ore sandstone, and charcoal produced from the abundant timber in the area. Once iron was produced, it was shipped out and formed into many different items, including ammunition and cannons for the Union Army during the Civil War.
- Hope School House: A one-room school that was refurbished in 1998.
- Moonville Tunnel: Moonville was a railroad station and loading place for timber and other products. The tunnel is about 100 yards in length and was constructed in the mid-1800's. The tunnel was rebuilt in 1903. Local legend holds that the Moonville Tunnel is haunted by the ghost.

Geology

Generally, the topography of the Raccoon Creek Headwaters is typical of the unglaciated region of southeast Ohio. Steep hillsides, narrow ravines, attenuated ridges, and relatively narrow stream valleys with constricted floodplains characterize the topography. Rock outcrops and overhangs are also common geologic features of the landscape. Most ridge tops have elevations of 600 to 1,100 feet. Valleys range between 0.25 and 0.50 miles wide with occasional broader stretches of undulating and gently rolling terrain. The average fall of the creek is 3.8 feet per mile. The steep topography of the watershed limits land uses such as cropland to the lowland areas and exacerbates problems with soil erosion, sedimentation, and acid mine drainage which is primarily the result of abandoned coal mining sites.

The Raccoon Creek Headwaters lie wholly within the unglaciated Allegheny Plateau region of the Appalachian Mountain range. Principally, the bedrock of the Raccoon Creek Watershed is composed of sedimentary rock from the Mississippian and Pennsylvanian geologic time periods. The Mississippian System, which formed 325 million to 345 million years ago is comprised of the Cuyahoga and Logan members. The Cuyahoga member consists of shale overlain by Blackhand sandstone. The Logan member is made of sandstone, shale, and conglomerate and overlies the Cuyahoga member. The Logan member is in-turn overlain by the Pottsville, Allegheny, and Conemaugh Formations of the Pennsylvanian System, which are about 280 million to 325 million years old. (Slucher et al., 2006)

In Ohio, these three formations include coal seams of various thicknesses, all of which have been mined to some degree. In addition, more than 90% of the coal produced in Ohio is extracted from the Allegheny and Monongahela Formations. In this region of Ohio, sedimentary deposits or distinctions between the major Pennsylvanian Formations were originally made based on mineral coal amounts and therefore constitute a pragmatic rather than a lithological framework for identifying formations. Coal mining in the Raccoon Creek headwaters consisted of mostly surface mining with some underground mines on the eastern border with the Hewett Fork subwatershed. The total amount of surface mined area in the watershed is 5,745 acres compared with 1,425 acres of underground mines. Total mining makes up 0.9 % of the total watershed area (Map 5).

Though the Headwaters lie strictly within the unglaciated portion of Ohio, the glaciers that entered Ohio from the north created changes to the geology, soils, and drainage patterns of the watershed. Prior to the earliest three glaciation events, Ohio was drained by the Teays River and its tributaries. The headwaters of the Teays River originated in present day North Carolina and are believed to have flowed through West Virginia, Ohio, Indiana, and Illinois (Hansen, 1995). As glaciers moved into Ohio they blocked the Teays River, forming Lake Tight which inundated large areas of southeastern Ohio (approximately 7,000 square miles in total area). As the water level rose in Lake Tight, the water overtopped the confining hills and the present day drainage system developed. The present drainage pattern, which shaped the Raccoon Creek watershed, began forming over 300,000 years ago. The Raccoon and Little Raccoon Creeks and their tributaries presently drain into the Ohio River basin.

Soils

The topography of Vinton and Hocking Counties has a great influence on the formation of soils. It effects soil formation through its effects on drainage, runoff, and erosion (Lemaster & Gilmore, 1998). Soils in the Raccoon Creek Headwaters and in the region are principally of sandstone and shale origin and formed from colluvium. Generalized soil types specific to the Raccoon Creek Headwaters watershed fall into five categories (Map 6). The Omulga-Doles soil type is generally found in the Raccoon Creek valley and some of the larger tributaries to Raccoon Creek. The Omulga and Doles series both occur on terraces and are classified as very deep. Omulga soils are moderately well drained and range in slope from 0 – 15 percent while the Doles series are poorly drained and on slopes from 0 – 2 percent. The other generalized soils types found in the watershed are found mostly on hills and hill slopes, are shallower, and moderately drained. The Steinsburg series found east of Lake Hope is the steepest soil type in the watershed with slopes up to 70 percent. Although there is too much information about soils to be referenced here, detailed soils information can be found at www.ohiosoils.com and is needed for specific restoration site plans or for planning purposes.

Biological Features

Historically, the native plant community of the Headwaters was predominately deciduous hardwood forest (98%) typical of the Allegheny Plateau region. Major forest associations

included mixed oak forests, mixed mesophytic forests and bottomland hardwood forests. These forest types were composed of canopy species such as American chestnut, and chestnut oak on knobs and ridges while red, black, and white oaks occupied the ravines. White ash, yellow poplar, American beech, hemlock, sugar maple, and hickory (sp) were also common species of the mixed mesophytic forest. The bottomland hardwoods were dominated by sycamore, cottonwood, black willow, yellow buckeye, green ash, red and silver maple, red and American elm and river birch. Prominent understory woody plants include flowering dogwood, redbud, spicebush, bladdernut, paw paw, rhododendron, and wahoo.

Currently, forest covers 309,209 acres or 80 % of Raccoon Creek watershed, consisting mainly of "second growth" mixed mesophytic deciduous forest. Extensive timbering, agriculture, iron ore industry, and coal mining have reduced the percentage of mature forest in the watershed since settlement, however many of these acres have reverted or are presently reverting to woodland.

Historically, wildlife denizens of the Headwaters include large mammals such as the mountain lion, woodland bison, and timber wolf. However, by the late 19th century, these species were extirpated from the region by unregulated trapping, hunting, and destruction of habitat. Forest recovery during the mid-twentieth century led to the reintroduction of formerly extant species such as the white-tailed deer, beaver, and wild turkey, all of which have returned to healthy populations within the watershed. The forest also furnishes important breeding habitat for area sensitive neo-tropical bird forest species such as the cerulean warbler and black and white warbler.

The Ohio Department of Natural Resources, Division of Natural Areas and Preserves (DNAP) maintains a list of rare, threatened, and endangered plant and animal species in the State of Ohio. Important endangered species found in the Headwaters are the bobcat, Uhler's Sundragon, blue corporal, and Madagascar ruffle lichen. A summary of all listed species is found in Table 4 and Map 7. It is important to note that these are confirmed occurrences of these species and other rare plant and animal species are likely present in the watershed but have not been officially reported. Occurrences of rare plant and animal species may be reported to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves (614-265-6453; http://www.ohiodnr.com/dnap/about.htm).

Invasive Nonnative Species

Several noxious and invasive plant species occur throughout the watershed. The Division of Natural Areas and Preserves has identified more than 60 nonnative plants that negatively impact forest regions in Ohio. Some of the top invasive species such as Japanese honeysuckle (*Lonicera japonica*), bush honeysuckle (*Lonicera* species), and garlic mustard (*Alliaria petiolata*) occur within the watershed.

Bush and Japanese honeysuckle are especially disruptive to forest ecosystems because they suppress and displace native shrubs and trees, altering the structural features (groundcover to canopy layering or strata) and composition of the forest. Consequently, structural disturbances created by invasive plants eliminate important niches for breeding

birds, thereby potentially reducing native bird populations. Similarly, garlic mustard competes and supplants native herbaceous ground cover, particularly spring wildflowers such as spring beauty, wild ginger, bloodroot, and trilliums.

Invasive plants, according to the ODNR, Division of Natural Areas and Preserves are a major threat to natural forest plant communities in Ohio and a critical management issue that is difficult to resolve. The division offers management suggestions and information on invasive plants through facts sheets and brochures, which are free to the public and available on-line at http://www.ohiodnr.com/dnap/about.htm.

Water Resources

The Raccoon Creek Headwaters is located in Southeast Ohio, which in general has a temperate climate generally characterized by well-defined seasons. Typically, in winter, the average daily minimum temperature is 22 degrees Fahrenheit. The lowest temperature on record, which occurred on January 17, 1977, is -22 degrees. The average temperature for the period 1931-1980 was 53 degrees Fahrenheit. This area has an average rainfall of 40-41 inches per year (Harstine, 1991).

Wetlands

All wetlands, regardless of size and type are ecologically valuable to maintaining a healthy landscape. Wetlands have been called the kidneys of the landscape because they can filter out sediments from surface water and absorb surplus chemicals. Wetlands also replenish groundwater supplies and serve as water retention basins, thus contributing to local flood control. Wetlands are particularly important to wildlife. Nearly 32% of Ohio's endangered species live in wetlands. Twenty percent of the endangered species found in the Headwaters are wetland species. Over one-third of Ohio's wildlife depends upon wetlands for their survival.

Although less than one percent of the Raccoon Creek watershed's land use types are wetlands, the wetlands that do exist are unique and specific to forest ecosystems, such as the buttonbush shrub swamp and submergent riverine community. Both of these wetland types furnish habitat for rare salamanders, the prothonotary warbler, and waterfowl species like the wood duck and black duck.

Wetland types found in the Raccoon Creek watershed include wet woods (1%), open water including deep water marshes (61%), shallow water marsh (22%) and scrub/shrub (16%). In the Raccoon Creek Headwaters watershed there are 782 acres of wetlands, which include open water and surface-mine ponds (Map 8). The largest wetland category is "strip-mine ponds" with 44% of the total wetland area, which in most cases those ponds do not have typical wetland characteristics and are many times acidic from mine drainage. The second largest category of wetlands is open water, which accounts for 34% of total area and includes Lake Hope. Approximately 170 acres are wetlands classified as wet-woods, shallow marsh, and shrub-scrub types.

Table 4. Ohio Department of Natural Resources Rare and Endangered Species List

Common Name	Scientific Name	Year Recorded	State Status	Managed Area
Plant List - Rare				
Butternut	*Juglans cinerea*	2005	Potentially threatened	
Umbrella Magnolia	*Magnolia tripetala*	2001	Threatened	
American Chestnut	*Castanea dentata*	1983	Potentially threatened	
Green Adder's-mouth	*Malaxis unifolia*	1963	Potentially threatened	Lake Hope State Park
Large Marsh St. John's-wort	*Triadenum tubulosum*	1998	Threatened	Zaleski State Forest
Netted Chain Fern	*Woodwardia areolata*	2001	Potentially threatened	Zaleski State Forest
Tubercled Rein Orchid	*Platanthera flava*	1963	Potentially threatened	Zaleski State Forest
Reflexed Sedge	*Carex retroflexa*	1963	Threatened	Zaleski State Forest
Animal list - Rare				
Bobcat	*Felis rufus*	2002	Endangered	Zaleski State Forest
Blue Corporal	*Ladona deplanata*	1995	Endangered	Zaleski State Forest
Uhler's Sundragon	*Helocordulia uhleri*	1999	Endangered	
Mud Salamander	*Pseudotriton montanus*	1962	Threatened	Zaleski State Forest
Coal Skink	*Eumeces anthracinus*	1970	Special concern	Zaleski State Forest
Fungus -Rare				
Madagascar Ruffle Lichen	*Parmotrema madagascariaceum*	1993	Endangered	
Pink Dot Lichen	*Dibaeis absoluta*	2002	Threatened	Zaleski State Forest
Unique Plant Communities and Animal Assemblages				
Buttonbush shrub swamp		1981		
Submerged riverine community		1983		Zaleski State Forest
Mixed emergent marsh		1983		Zeleski State Forest
River birch-maple floodplain forest		1983		Zaleski State Forest
Breeding Amphibian Site		2002		Zaleski State Forest

Groundwater

In the state of Ohio, sedimentary bedrock from the Silurian, Devonian, Mississippian and Pennsylvanian systems comprises the dominant bedrock groundwater sources, and precipitation is the primary recharge to aquifers here. The Pennsylvanian system is the bedrock of the Raccoon Creek watershed. Groundwater in this system is found in sandstone, shale, and fractured coal, with a general yield of zero to twenty-five gallons per minute. The best water-producing zone occurs in the Sharon Conglomerate and water quality depends on the presence of coal. Quality is relatively high with respect to sulfate, iron, manganese, and total dissolved solids.

Groundwater is the dominant source of domestic water supply in the Raccoon Creek watershed through either private wells or public systems like Le-Ax Water. Le-Ax water draws its water supply from the Hocking Valley to the east of the Raccoon Creek Headwaters watershed. Compared to the rest of the state, southeast Ohio has relatively little groundwater, at flows of less than five gallons per minute. Most of Vinton County yields less than three gallons of water per minute. This bedrock contains sandstone, shale, fireclay, coal, and limestone. A large section of the Blackhand sandstone lies in the central and north eastern part of the county and extends north to Hocking County. This bedrock yields five to twenty-five gallons per minute with more mineralized water found in the east. Aquifers in this area are sand and sandstone.

The southeastern part of Hocking County that lies in the watershed ranges between one and twenty-five gallons per minute. Starr Township consists of sandy shale and sandstones and has some very deep wells, a few being more than 500 feet deep. Washington Township, however, receives water from the Blackhand sandstone aquifer, and therefore has well depths between 165 and 400 feet.

The Ohio EPA Division of Drinking and Ground Waters provides ground water pollution potential data for Hocking County, but Vinton County data is not yet available. The DRASTIC method is the primary tool used by the Ohio EPA in evaluating the hydrogeologic sensitivity of the aquifer to contamination. It uses a relative ranking scheme, called the DRASTIC index, to help prioritize ground water resources with respect to their vulnerability to ground water contamination. Overall, the groundwater regions of the Raccoon Creek Headwaters have a low vulnerability to groundwater pollution. Stream valleys of East Branch, West Branch, and Honey Fork are the most susceptible to groundwater pollution according to the DRASTIC index scoring in the 100 – 139 range. All other areas scored below 79 (low threat) or were not ranked.

No source water protection areas for groundwater exist in the Raccoon Creek Headwaters, either for groundwater or surface water.

Surface Water

For purposes of this watershed management plan, the Raccoon Creek Headwaters is defined as the land area that drains from the headwaters of East and West Branches of Raccoon Creek to upstream of the confluence with Hewett Fork. The mainstem of Raccoon Creek is approximately 26 miles long in this section with a gradient of 2.62 feet per mile. There are ten named streams (including Raccoon Creek) listed in the ODNR Gazetteer of Ohio Streams within the Raccoon Creek Headwaters (Table 5). Six are direct tributaries to Raccoon Creek; East Branch, West Branch, Sandy Run, Wheelabout Creek, Brushy Fork (Creek), Rocky Branch and Twomile Creek. West Branch has two named tributaries, Honey Fork and Claylick Run (which is a tributary to Honey Fork). Sandy Run, which is the tributary that feeds Lake Hope, has one named tributary, Little Sandy Run. Two tributaries to Brushy Fork (Creek) not listed are Dunkle and Siverly Creek in Vinton County.

The only significant lake in the Headwaters is Lake Hope (Figure 4). It is a 120-acre recreational reservoir fed by Sandy Run and is owned and managed by the Division of Parks, Ohio Department of Natural Resources (ONDR). Information on Lake Hope can be attained through ODNR at http://www.dnr.state.oh.us/tabid/754/default.aspx.

Table 5. Streams in the Raccoon Creek Headwaters
(source: ODNR, Gazetteer of Ohio Streams)

Stream Code	Stream Name	Flows Into	County (at mouth)	Length (miles)	Elev. (source)	Elev. (mouth)	Ave. Fall (ft/mile)	Drains (sq. miles)
389.34	Sandy Run	Raccoon Creek	Vinton	6	850	685	27.5	11.5
389.3401	Little Sandy Run	Sandy Run	Vinton	1.8	760	685	41.6	1.48
389.35	Wheelabout Creek	Raccoon Creek	Vinton	4.4	790	695	21.6	11.9
389.36	Brushy Fork (Brushy Creek)	Raccoon Creek	Vinton	10.8	1015	715	27.8	33.8
389.37	Rocky Branch	Raccoon Creek	Vinton	1.4	800	730	50	1
389.38	Twomile Run	Raccoon Creek	Vinton	3.2	810	735	23.4	4.99
389.39	East Branch	Raccoon Creek	Vinton	7.7	900	750	19.5	20
389.40	West Branch	Raccoon Creek	Vinton	8.1	935	750	22.8	22.7
389.4001	Honey Fork	West Branch	Vinton	5.8	860	755	18.1	10.5
389.400101	Claylick Run	Honey Fork	Hocking	1.7	900	790	64.8	1.78

Figure 4. Picture of Lake Hope, Lake Hope State Park

There are no USGS stream gages maintained by the U.S. Geological Survey in the Raccoon Creek Headwaters, but the gage located near Bolins Mills is only several miles downstream of the basin. The gage is located on the left bank of Raccoon Creek at the state route 50 and 356 intersection, at approximately river mile 86 and can be found online at http://waterdata.usgs.gov/oh/nwis/uv?03201902. It monitors a drainage area of 205 square miles and records real time flow data. Real time water quality data is not monitored at this gage station.

Recreation in the Raccoon Creek in the Headwaters watershed is very much a part of the local history and pastimes. Raccoon Creek provides recreational opportunities such as fishing, swimming (although not legal within Zaleski State Forest), and canoeing. Currently the Raccoon Creek Water Trail Association is planning and developing a water trail plan for state water trail designation by the Ohio Department of Natural Resources Division of Watercraft. Although still in the planning stages, three sites will likely by part of the water trail plan for Raccoon Creek in this watershed area: SR 278 in Zaleski, Wheelabout Road near Hope School House, and Hope-Moonville Road at the Moonville Tunnel. These sites correspond with access points to the Moonville Rail Trail that is concurrently being planned by the Moonville Rail Trail Association. Raccoon Creek is typically only paddleable during spring and winter in this section when water levels are high. Strainers and shallow areas make paddling in the summer difficult. The Raccoon Creek Partnership has conducted a successful annual float in May in this section of Raccoon Creek for the past seven years.

Physical Attributes

The terrain of the Raccoon Creek Headwaters consists of steep hillsides with narrow to wide valleys. Surface elevations range from 600 – 1100 feet above mean sea level. Although gradients of most headwater channels and small tributaries are relatively steep the gradient of Raccoon Creek valleys and some valleys associated with larger tributaries is fairly low. For example, the average gradient in Raccoon Creek in the headwaters is 2.62 ft/mile. The low gradient of Raccoon Creek is due to the fact that Raccoon Creek

lies in several valleys created by pre-Wisconsin Age glaciation rivers of the Teays River system. These ancient valleys with both pre-glacial and glacial outwash soils house streams in the Raccoon Creek drainage that are typically undersized for the valley type.

The majority of streams in the study area are defined by pool/riffle/run morphology, with locally glide/pool dominated morphology. The dominant substrate material in Raccoon Creek is sand, with clay, silt, and gravel sub-dominant in certain locales. Large material (i.e. cobble and boulder) are only present in locations when the stream encounters a hillside and recruits bedrock (shale and sandstone) into the stream substrate. Habitat varies from stream to stream but is generally described as slow moving water with deep pools, abundant woody cover, sand substrate, and few riffles caused by coarse substrate. Smaller headwater tributaries of course have higher gradient and thus have more riffle habitat and a higher degree of larger substrate. Raccoon Creek is typically deep, even in the headwaters, and slow with abundant woody vegetation and riparian habitat. In fact, only a few miles of the 26 miles of Raccoon Creek have sparse riparian vegetation. A majority of the creek flows through Zaleski State Forest and has a completely forested riparian zone and floodplain. Out of five QHEI scores on the mainstem of Raccoon Creek, all scores were a 7.5 or higher out of 10 possible points on the riparian metric (McCament, 2006).

Hughes and McCament (2006) found that suspended sediment load in the Upper Basin of Raccoon Creek were higher than expected in a Sediment Total Maximum Daily Load (TMDL) for the Upper Basin of Raccoon Creek in 2006 (McCament, 2006). The TMDL set targets for both channel stability and total QHEI. The QHEI target was based on Ohio EPA's statewide target of 60. A channel stability index (Simon, 2004) was collected at 12 sites in the Upper Basin, but only one of those sites, Wheelabout Creek, was in the Raccoon Creek Headwaters. Channel stability targets are based on Simon (2004) which demonstrated that unstable channels have higher sediment loads than stable channels. Managing for stable channels provides a good functional goal to reduce sedimentation, especially in watersheds where bank erosion is most likely the highest source of channel sediment. Physical attribute and habitat data will be discussed in more detail in each 14-digit HUC action plan in Section II.

No impoundments or low head dams have been recorded on the mainstem of Raccoon Creek. The only tributary dammed in the Raccoon Creek Headwaters is Sandy Run, which contains Lake Hope State Park. However, beaver activity is high in the region and many streams are constantly changing due to beaver dams being built and washed away by flood stage waters. Although many small channels have been altered or channelized for agriculture historically, this remote area of Raccoon Creek appears to have had few channelized streams. In fact, it appears that the mainstem of Raccoon Creek has not been channelized for any considerable length throughout the headwaters region. Channel alterations from railroads and former mining towns are still apparent in small reaches but negligible overall.

The maximum discharge measured at the Bolins Mills USGS gage on Raccoon Creek several miles downstream of the Headwaters watershed was 5,000 cubic feet per second

(cfs) in 2004. This event reached a flood stage of 17.05 feet, approximately six feet over bank full stage. This USGS gage was installed in 2003 and has only been recording discharge and stage for the last four years. The highest monthly mean flow is April with 450 cfs and the lowest is August with 34 cfs. Discharge of approximately 1,000 cfs, which is close to top of bank flows, has occurred 3 – 4 times per year over the past four years of record. Floodplain connectivity appears to be quite good with flooding a common yearly occurrence in the Raccoon Creek Headwaters. The floodplains in the watershed are undeveloped with the only village located on Raccoon Creek in the Headwaters being the town of Zaleski. However, Zaleski is on an adjacent hillside mostly above the Raccoon Creek floodplain.

Physical attributes and habitat conditions of streams will be more closely analyzed for each 14-digit HUC watershed in Section II, watershed action plans.

Water Quality

The Ohio EPA uses several structural indices to measure habitat quality and assess the health of aquatic communities in order to determine use designations. Indices used by the Ohio EPA are the Index of Biotic Integrity (IBI), the Invertebrate Community Index (ICI) and the Qualitative Habitat Evaluation Index (QHEI).

The IBI is a measure of fish species populations and species diversity. The criteria used to establish the index reflect the biological performance exhibited in natural or least-impacted habitats. The IBI index is a number that reflects total native species composition, indicator species composition, pollutant intolerant and tolerant species composition, and fish condition. The highest possible score is 60, with higher scores indicating healthier aquatic ecosystems. Depending on the pollution tolerance of individual species, the IBI is a general indicator of which species are likely to be found in a given stream. The ICI is derived from measurements of the macro-invertebrate communities living in a stream or river. The ICI is particularly useful in evaluating stream health because a large number of macro-invertebrate taxa are known to be either pollution tolerant or intolerant. Like the IBI, the ICI scale is 0-60, with higher scores reflecting healthier macro-invertebrate communities and therefore more biologically diverse aquatic ecosystems.

The QHEI is a quantitative assessment of the physical characteristics and in-stream geography of streams and rivers (Rankin, 1989). The QHEI is essential in evaluating land use practices and stream disturbance. Six variables comprise the QHEI metric: substrate type and quality, in-stream cover, channel morphology, riparian zone, pool quality, and riffle quality. The QHEI scale is 0-100, with higher scores reflecting less disturbed and therefore higher quality streams.

The Ohio Water Quality Standards stated in chapter 3745-1 of the Ohio Administrative Code contains language that defines designated uses and chemical, physical, and biological criteria for surface waters, and are designed to represent measurable properties of the environment. Rivers and streams in Ohio receive "use designations" that reflect the aquatic habitat the stream can support and how the water is used. Water quality standards

are then established to support those uses. In applications of Ohio water quality standards to management of water resource issues, aquatic life use criteria frequently control protection and restoration requirements. Generally, emphasis on protecting aquatic life results in attaining water quality suitable for all uses, hence the emphasis of aquatic life uses in water quality reports and planning. The four different aquatic life uses currently defined in the Ohio water quality standards which are potentially applicable to streams in the Raccoon Creek watershed, and the intent of each with respect to the role of biological criteria, are described in the following section. Table 6 summarizes the minimum biological criteria scores for each habitat designation in the Western Allegheny Plateau Ecoregion, of which southeast Ohio is a member.

Table 6. Ecoregion Biocriteria: Western Allegheny Plateau (OEPA, 1997)

	EWH	WWH	MWH	LRW-AMD
QHEI	75	60	45	NA
ICI	46	36	30	8
IBI*	50	44	24	18
*wading and headwater sampling methodology				

Warmwater Habitat

This designation defines the typical warmwater assemblage of aquatic organisms in Ohio's rivers and streams; waters so designated are capable of maintaining a balanced, integrated, and adaptive community of warmwater aquatic organisms. Biological criteria are stratified across five ecoregions for the WWH designation. This aquatic use designation represents the principal restoration target for the majority of water resource management planning in Ohio.

Exceptional Warmwater Habitat (EWH)

This designation is for waters capable of supporting and maintaining an exceptional or unusual community of warmwater aquatic organisms. These assemblages of organisms are characterized by a high diversity of species, particularly those that are highly intolerant, rare, threatened, endangered, or special status species. Biological criteria for EWH apply uniformly across Ohio. The EWH designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.

Modified Warmwater Habitat (MWH)

This designation applies to streams and rivers that have been found incapable of maintaining a balanced, integrated, and adaptive community of warmwater organisms. Streams and rivers designated MWH have been subjected to extensive and essentially permanent hydrological modifications. Aquatic assemblages in these streams generally comprise species that are tolerant of low dissolved oxygen, silt, and high nutrient concentrations. Biological criteria for MWH designation are stratified across five

ecoregions and three major modification types-channelization, free-flowing water impoundments, and extensive sedimentation due to mine runoff.

Limited Resource Water (LRW)

This designation applies to waters that have been found lacking the capacity to support any appreciable assemblage of aquatic organisms. Use attainability analysis has demonstrated that extant organisms are substantially degraded, and that the potential for recovery to levels characteristic of any other aquatic designation is precluded. Causative factors for the LRW designation include extensive channel modifications, acid mine drainage, and other factors relating to extensive urbanization. No formal biological criteria exist for the LRW aquatic use designation. The LRW-AMD designation applies to streams and rivers that have been subjected to severe acid mine drainage pollution from abandoned mine lands or gob piles, and where there is no near-term prospect for reclamation. The representative aquatic assemblages are generally composed of species that are tolerant to low pH, silt, metals, and overall poor habitat quality.

The Ohio EPA 2006 Integrated Report, which only lists attainment status on the 11-digit HUC scale, states that three categories of aquatic life use exist in the Raccoon Creek Headwaters and that impairment to those uses exists. Those three listed aquatic life uses are Exceptional Warm Water Habitat (EWH), Warm Water Habitat (WWH), and Limited Resource Water (LRW). Eight data points exist for secondary tributaries (< 5 mi2), eight data points exist for primary tributaries (5 – 50 mi2), and four data points for principal streams (50 – 500 mi2) from years 1995, 1996, 2000, and 2002. Only one of the four secondary tributaries was not meeting its designated use. Sixty four percent (64%) of primary tributaries are non-attaining, 27.9% are partially attaining, and 8.1% are fully attaining their aquatic life use. Twenty two miles of principal streams were assessed and forty six percent (46%) (20 – 500 mi^2) are in full attainment, 53.1% are in partial attainment, and 0% are in non-attainment. The next scheduled assessment by Ohio EPA will be in 2019.

In addition to biological monitoring using Ohio EPA protocols, watersheds in Southeast Ohio including Raccoon Creek have collected macroinvertebrates and analyzed them using the Macroinvertebrate Aggregated Index for Streams (MAIS) (Smith & Voshell, 1997). MAIS requires identification to family-level, relies on natural substrate methods, places a stronger weight on the diversity and abundance of taxa (found in the dip net samples) than ICI and requires only one field trip for site collection. MAIS collections have also been approved by OEPA as Level II data throughout the WAP ecoregion. Nine metrics comprise the final MAIS index score and each is assigned a score from 0 to 2. Individual metric scores are summed to produce a single numeric score between 0 and 18. Scores are divided into four categories: 0-7 = “Very Poor (VP);” 8-11 = “Poor (P);” 12-15 = “Good (G);” and 16-18 = “Very Good (VG).”

Water quality in the Raccoon Creek headwaters is mostly affected by non-point source pollution. The dominant non-point source pollutant is Acid Mine Drainage (AMD). AMD is generated when coal mining, either surface or underground, exposes iron pyrite

in bedrock units to water and air. The result is an oxidation reaction that creates sulfuric acid. A simplified version of this reaction is listed below.

$$4FeS_2 + 15O_2 + 14H_2O = 4Fe(OH)_3\text{-} + 8H_2SO_4$$
Pyrite + Oxygen + Water = Ferric Hydroxide + Sulfuric Acid

The sulfuric acid then dissolves heavy metals in the bedrock in high concentrations. These heavy metals, mostly iron, aluminum, and manganese in highest concentrations, convert to hydroxides and precipitate as a solid when buffered and pH is raised. This solid is referred to as flocculent (floc) or yellow boy due to its yellow-orange color caused by iron (Figure 5).

Figure 5. Acid Mine Drainage in an Unnamed Tributary to Brushy Creek

Point sources of pollution are rare in the Raccoon Creek Headwaters because it is so undeveloped. The village of Zaleski does not have a centralized wastewater treatment facility, but this is under development with Ohio EPA. Two entities have a National Pollutant Discharge Elimination System (NPDES) permit in the watershed, which are ODNR (Lake Hope State Park) and the Austin Powder Company which discharges into an unnamed tributary to Raccoon Creek upstream of the village of Zaleski. No recent spills and illicit discharges have been recorded.

According to the Ohio EPA 2003 Upper Basin TMDL, biological data indicates that none of the streams where data was collected are attaining their designated use. Four streams are listed as partial attainment and four are listed as non-attaining (Table 7). However, two streams where the aquatic life designated use was listed as Limited Resource Water – Acid Mine Drainage (LRW-AMD) have been recommended to be upgraded to Warm-Water Habitat (WWH).

Table 7. Biological Data and Aquatic Life Use Information (1996- 2000) for the Raccoon Creek Headwaters Watershed

Stream (stream code)	River Mile	IBI	ICI	QHEI	Designation	Attainment Status	Causes of Impairments
Raccoon Creek (09-500)	89.5 - 111.9	18	16	60	WWH	Non	metals, pH
Raccoon Creek (09-500)	66.4 - 89.5	40 / 36	46 / 38	61 / 62	WWH	Full	metals, pH
Raccoon Creek (09-500)	47.67 - 66.4	44	32 / 48	47 / 63	WWH	Partial	metals, pH
Raccoon Creek (09-500)	37.55 - 47.67	41	38	47	WWH	Partial	metals, pH
East Br. Raccoon Creek (09-574)	0.1 - 6.6	12	9	68	WWH	Non	metals, pH
Honey Fork (09-576)	0.5 - 1.5	30	Fair	76	WWH	Partial	habitat, sediment
West Br. Raccoon Creek (07575)	0.2 - 5.7	24	38/Fair	58	WWH	Non	metals
Two Mile Run (09-573)	0.2	28	Good	63	WWH	Partial	metals
Brushy Fork (09571)	0.4 - 9.1	16	V. Poor	47/64	WWH	Non	pH
Dunkle Creek (09-590)	0.7 - 0.9	34	M. Good	64	WWH	Partial	metals
Wheelabout Creek (09-570)	0.6	28	Good	67	WWH	Partial	sediment
Sandy Run (09-568)	2.7 - 5.2	18	NA	56.5	WWH	Non	metals, pH
Lake Hope (09-568)	NA	NA	NA	NA	EWH	Partial	metals, pH

The primary causes of non-attainment of water quality standards in the Raccoon Creek Headwaters are pH and metals related to AMD. The Upper Basin Raccoon Creek TMDL by Ohio EPA in 2003, which covers three HUC 11 watersheds including the Raccoon Creek Headwaters, states “due to the overwhelming presence of AMD in the Upper Raccoon Creek Basin, capturing and treating all the affected water would be difficult and cost prohibitive”. The only other listed causes of impairment listed by Ohio EPA are sediment/siltation and habitat for two named tributaries, Wheelabout Creek and Honey Fork. Lake Hope’s major causes of impairment also include organic enrichment/DO and taste and odor.

Although untreated sewage is not listed as a cause of impairment for any streams in the Raccoon Creek Headwaters in was listed as an issue in the 2003 Raccoon Creek Management Plan. County health department professionals estimated 40 – 50% of home septic systems failing and up to 80% in Vinton County. 83 – 91% of households have home septic systems in the townships in the Headwaters watershed (ILGARD, 2003). The village of Zaleski is in the planning stages of a public sewer system with Ohio EPA.

Figure 6. EPA 303(d) Listed Waters in the Raccoon Creek Headwaters
(source: Ohio EPA Upper Basin TMDL, 2003)

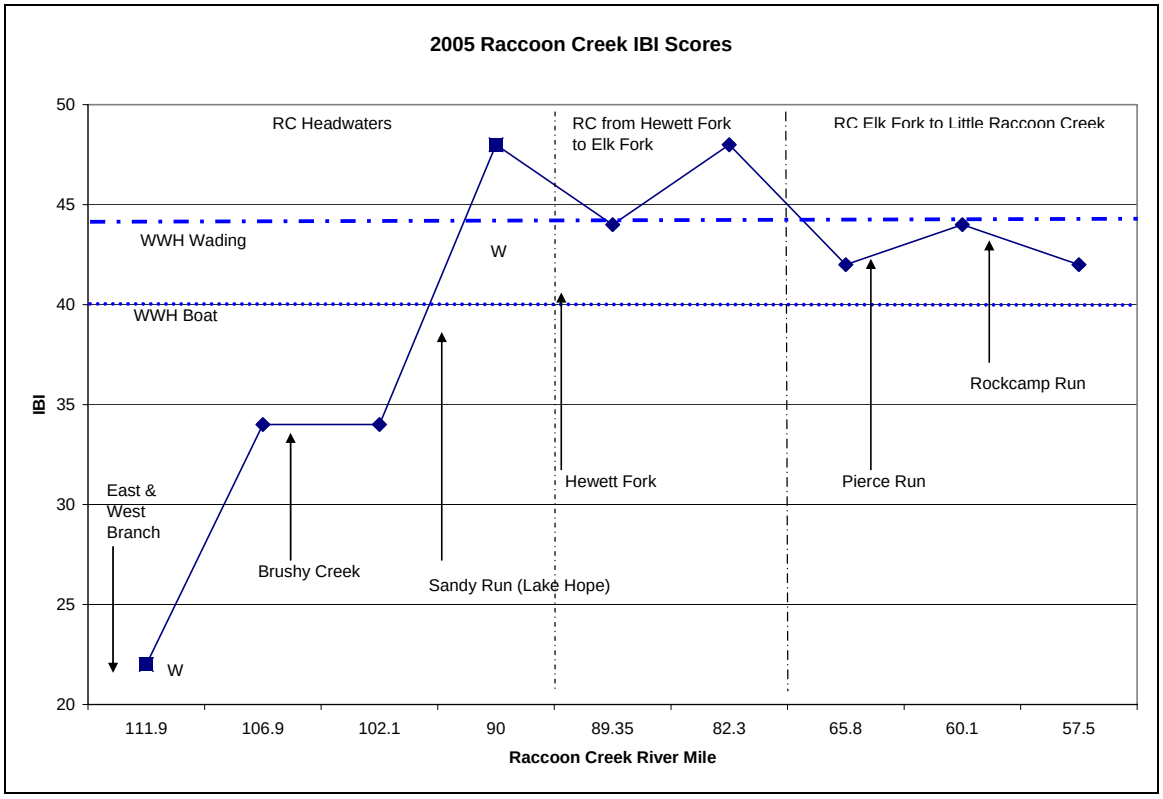
Table 1 - Summary of 1998 303(d) Listed Waters Included in This TMDL Report[1]

Waterbody Segment Description [Identification Number]	303(d) Status[1]		Major Causes 303(d)	Included in this Report?[2]	Comments
	1998	2002			
05090101-020 Raccoon Creek (hdw to Hewett) [was 05090101-045 on 1998 list]					
OH30-60 Raccoon Creek (East/West Branch to Brushy Fork)		✓	Metals	✓	
	✓	✓	pH	✓	
OH30-63 East Branch Raccoon Creek		✓	Metals	✓	
		✓	pH	✓	
OH30-64 West Branch Raccoon Creek		✓	Metals	✓	
OH30-62 Two Mile Run		✓	Metals	✓	
OH30-59 Brushy Fork	✓	✓	pH	✓	
		✓	Metals		
OH30-59.1 Dunkle Creek		✓	Metals	✓	
		✓	Habitat Alteration	No	
OH30-56 Sandy Run		✓	Metals	✓	
		✓	pH	✓	
		✓	Siltation	No	
OH30-56-390 Lake Hope	✓		Organic Enrichment/D.O.	☺	
	✓	✓	pH	✓	
	✓	✓	Siltation	No	
	✓	✓	Metals	✓	
	✓		Taste and Odor	☺	
OH30-65 Honey Fork		✓	Siltation	No	
05090101-030 Raccoon Creek (Hewett to Elk) [was 05090101-050 on 1998 list]					
OH30-58 Wheelabout Creek		✓	Siltation	No	

** Wheelabout Creek is incorrectly labeled as a tributary to HUC-11 watershed 05090101-030 in the Upper Basin Raccoon Creek TMDL (above, figure 6).*

There is a general trend of improving water quality in the mainstem of Raccoon Creek and some AMD impacted tributaries due to AMD treatment projects by the Raccoon Creek Partners, mine land reclamation by ODNR Division of Mineral Resources Management, and natural attenuation of acidic mine spoil piles. Recent water quality data in the mainstem of Raccoon Creek shows that water quality is most impaired by acid mine drainage near the headwaters and improves downstream. This correlates with biological data, as IBI scores improve as you go downstream from the headwaters of Raccoon Creek (Figure 7). The Raccoon Creek Partnership has focused its AMD restoration efforts in East Branch, West Branch, and Brushy Creek because those AMD streams appear to be limiting biological recovery in the Raccoon Creek Headwaters.

Figure 7. 2004 – 2005 IBI Scores on the Mainstem of Raccoon Creek; River Mile 111.9 to 57.5

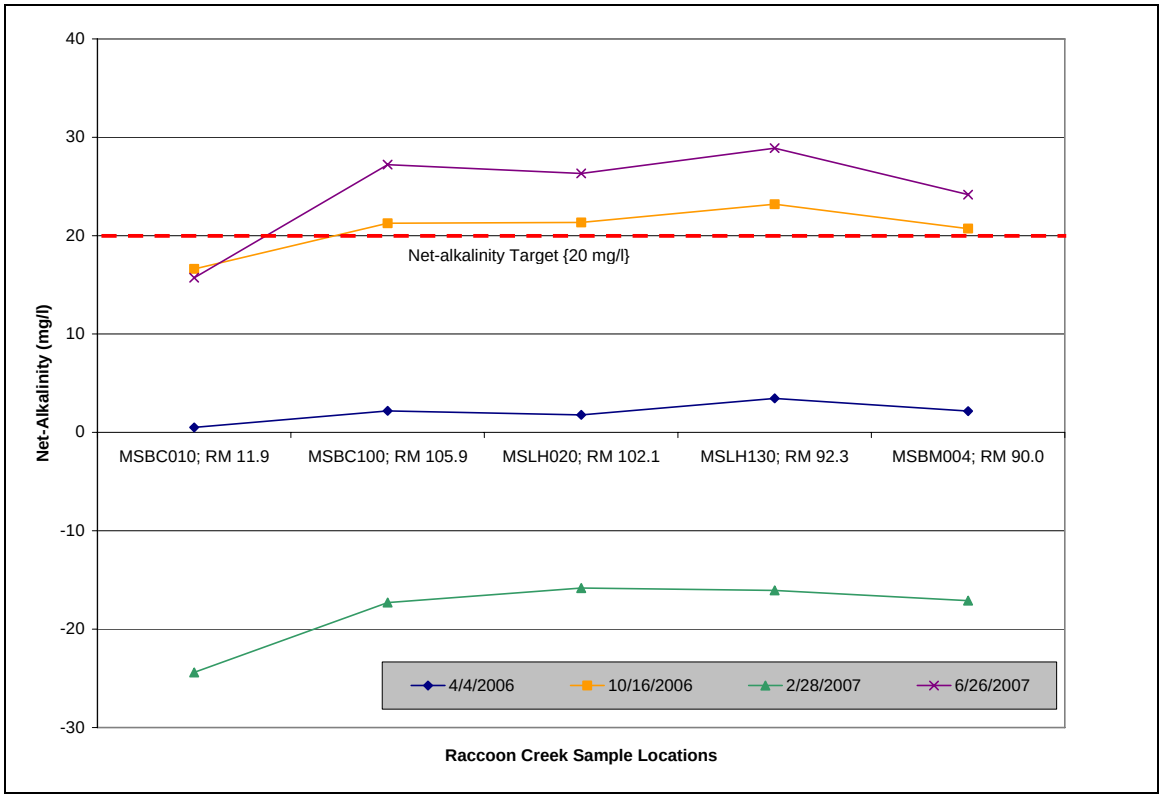


* W indicates wading site for fish sampling, all others are boat sites

Net-alkalinity data indicates a similar trend for improving conditions moving downstream from the confluence of East and West Branch (Figure 8). MSBC010 (RM 11.9) does not meet the net-alkalinity target of 20 mg/l for any of the four sampling events in 2006 and 2007 while all others meet at least during two sampling events. In fact, in February 2007, MSBC010 was net-acidic by 25 mg/l. MSBC010, directly downstream of East Branch and West Branch, appears to be the most degraded site on the mainstem of Raccoon Creek in terms of water quality and fish populations. A few trends are apparent in the data, net-alkalinity tends to improve downstream from the headwaters of Raccoon Creek, although only slightly because of limited alkaline water for buffering. The four lower most sites meet the net-alkalinity target during drier conditions (summer – fall) but do not

meet the target under wetter conditions (winter – spring). The February 2007 samples were taken during the highest flow regime (1,730 cfs at Bolins Mills USGS gage) show the highest concentrations of acidity and conversely the highest alkalinity concentrations were observed during the lowest flow regime (26 cfs at Bolins Mills) during June 2007. This is because of increased mine drainage from abandoned surface mines in the watershed during wetter months and during/after precipitation events. More acid is generated at surface mines when precipitation (i.e. runoff) and groundwater levels are high because there is more water available to interact with the acidic spoil and create AMD. It should be noted that MSBM004 is at RM 85.9 as shown in Figure 8, which does attain WWH according to fish data (IBI). Apparently, sites with periodic net-acidic conditions may still have high biological integrity if those events are not prolonged. The average net-alkaline concentration at MSBM004 for the four samples is 7.5 mg/l. In addition the field pH was never below 6.0 at any sites during any of these sampling events. The October 2006 and February 2007 sampling events did have pH's below the US EPA standard of 6.5 for all sites.

Figure 8. Net-Alkalinity Concentrations for Raccoon Creek Headwaters Mainstem Sites from 2006 - 2007



SECTION II.

WATERSHED ACTION PLANS FOR 14 DIGIT-HUC WATERSHEDS

East Branch of Raccoon Creek

14 Digit HUC: 05090101-020-010
Location: Confluence with Raccoon Creek at River Mile 111.9
USGS Quadrangle: Union Furnace, New Plymouth
Drainage Area: 19.95 square miles, 12,768 acres

Watershed Description

East Branch is located in the northeastern corner of the Raccoon Creek headwaters and is almost entirely contained within Hocking County, with a small portion in Vinton County near the confluence with Raccoon Creek. The main stem of East Branch is 7.7 miles long with a gradient of 19.5 feet per mile. There are no named tributaries to East Branch.

The only small villages in the watershed are Starr and Coonville. The watershed is mostly rural with 95% of land cover forested and 4% listed as agricultural / urban. However, this latter land use is mostly reclaimed surface mines because agriculture is minimal except in the lower portions of the East Branch valley. Coal has been mined in the East Branch for more than a century. Underground mining was the earliest form, affecting 576 acres or approximately 4%. Surface mining began in the early 1940s and continued well into the 1980s, affecting 1983 acres (or approximately 15%). Early surface mines were limited by technology and only removed a portion of the coal along the ridge margin. Later mining removed entire ridge tops but operated under more stringent environmental regulations. This resulted in a reclaimed ridge-core surrounded by an outer margin of abandoned surface mines. Common degradation features include orphaned highwalls, water-filled pits, barren spoil ridges, coal refuse dumps, and head-of-hollow valley-fills.

Water Quality

Biological

Due to East Branch's large AMD impacts, it has an aquatic life use designation of LRW-AMD. Ohio EPA (1997) reported East Branch in partial attainment of this LRW-AMD classification due to high aluminum, iron, manganese, and zinc concentrations and low pH. The 2003 Upper Basin TMDL recommended WWH as a designated use for East Branch, for which it would be in non-attainment. In 1995, East Branch at RM 6.6 was found to have an ICI of 9 and an IBI of 12; RM 0.1/2.1 had similar scores of 10 and 12 (OEPA 1997). Not a single fish was found living in East Branch in 1995. Macroinvertebrate abundance and richness values in Raccoon Creek collected in the spring, summer, and fall of 2000 documents East Branch with the lowest or one of the lowest richness and abundance scores amongst all seasonal samples.

Raccoon Creek at RM 109.1 – 108.9 (below East/West Branch confluence) reports low ICI and IBI values of 14 and 18, respectively. Macroinvertebrate communities were typified by "low densities, low numbers of taxa, and the absence of mayflies." Reasons for the partial attainment of LRW-AMD in this section of Raccoon Creek included low pH, and high aluminum, manganese, and zinc due to upstream AMD in East Branch (OEPA 1997).

Physical/Habitat

No man made dams have been identified on the mainstem of East Branch. Beaver dams are present throughout the watershed however, usually in smaller tributaries but occasionally in East Branch as well. Channelization is not evident in reaches sampled or evaluated. Channel alterations or loss of riparian vegetation is evident only in one location along SR 56, with most of the riparian corridor intact. Although severely impacted by AMD, East Branch has relatively little stream side development or modification and as such, retains fair to good QHEI scores. QHEI scores collected for the Sediment TMDL for the Upper Basin Raccoon Creek in 2007 at RM 0.1, 2.1, and 6.6 were 56.5, 67.5, and 91, respectively. Suspended sediment data and channel evolution data was not collected in East Branch for the 2007 Sediment TMDL so physical data such as sediment loading and channel instability is unknown.

Chemical

Historic data shows that East Branch is one of the most severely impacted AMD streams in the Raccoon Creek Headwaters, with high levels of AMD occurring throughout the entire length of stream. USGS (Wilson 1985; Wilson 1988) documented water quality at river mile (RM) 2.5 with a pH of 3.3 to 3.8 and an acidity concentration of 184 mg/l. Ohio EPA (1997) reported that East Branch at RM 6.6 was exceeding the USEPA pH standard of 6.6 – 9.0 criteria, with pH consistently in the mid to high 3 range.

East Branch at RM 0.1 (EB010) had a cumulative concentration of 59 mg/l of net-acidity according to modeling results from the Ohio EPA Upper Raccoon Creek Basin TMDL (2003). This was the largest deviation from the 20 mg/l net alkalinity target of any modeled stream in the 386 square mile study area. Water quality data has been regularly monitored at EB010 since 2000 by the Raccoon Creek Partners. Only two sample events since 2004 (Figure 9) were net alkaline and the majority of time it was severely acidic. Acidity, pH, iron, and aluminum all consistently exceed water quality standards or criteria (Table 8). Water quality varies seasonally (and even daily) in East Branch because discharges from abandoned and reclaimed surface mines leach increased amounts of acidity with increased precipitation and higher groundwater levels.

Figure 9. Net-Alkalinity and pH Data for the Mouth of East Branch (EB010)

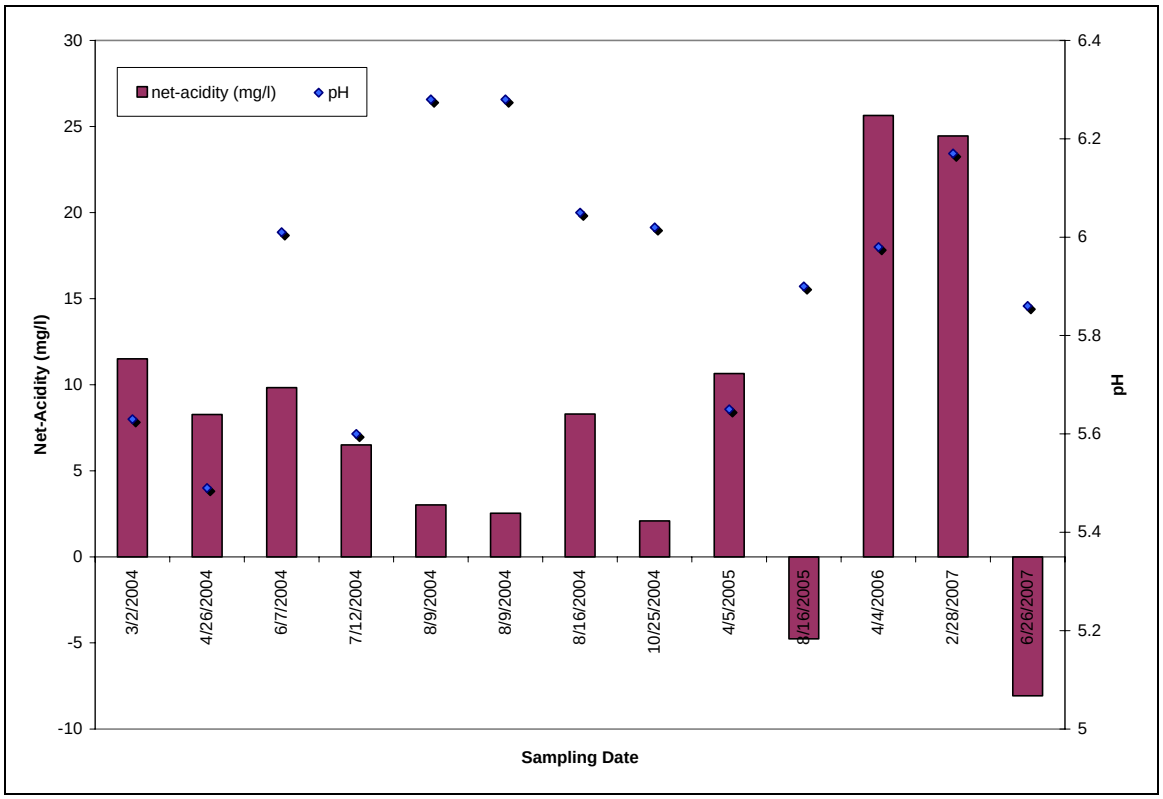


Table 8. East Branch Data Summary for River Mile 0.1 (EB010), 2000 – 2007

Parameter	Data Range	Target or Criteria
pH	4.5 – 6.8	6.5*
Acidity	31 – 8 mg/l	-20 mg/l**
Acidity loading	4,562 – 1 lbs/day	NA
Mean annual acidity loading	672 lbs/day	NA
Dissolved iron	1 – 0.3 mg/l	1.0 mg/l***
Dissolved aluminum	3 – 0.3 mg/l	0.85 mg/l***

* USEPA water quality standard, minimum concentration
** Ohio EPA Upper Basin Raccoon Creek target concentration
*** USEPA national recommended water quality criteria

Although AMD is prevalent in many tributaries to East Branch, the 2002 Raccoon Creek Headwaters AMDAT (Rice 2002) concluded that four tributaries were contributing the majority of AMD, and if treated would likely lead to a net-alkaline discharge to Raccoon

Creek. Those four tributaries are EB120, EB160, EB190, and EB210. Mean annual acid loading (Stoertz, 2004) for each tributary is listed in table 9 for comparative purposes.

Table 9. Acid Loading by Four Major AMD Priority Tributaries in East Branch

Tributary	Mean Annual Acid Loading
EB120	200 lbs/day
EB160	486 lbs/day
EB190	801 lbs/day
EB210	857 lbs/day

Problem Statement

The East Branch of Raccoon Creek is not attaining its recommended (Ohio EPA, 2003) designated use of WWH from RM 0.1 – RM 6.6. The causes of non-attainment are pH and metals associated with AMD. The 2002 Raccoon Creek Headwaters AMDAT Report ranks East Branch as the highest priority sub-watershed for AMD abatement measures. Extensive reclaimed or un-reclaimed surface mines and gob piles are present in East Branch, contributing high acid and metal loads to the mainstem of East Branch and Raccoon Creek. Although other water quality impairments may be present in the basin, the severe degradation caused by AMD limits any chance of biological recovery in East Branch until addressed through remediation efforts.

Goals

1. Reduce acid loads at EB160, EB190, and EB210 to eliminate the mean annual acid load of 672 lbs/day at the mouth of East Branch.

Action Plan

TMDL modeling (Ohio EPA 2003) indicates that if all AMD treatment projects suggested by the Raccoon Creek Headwaters AMDAT were implemented in the basin there would be a decrease in cumulative net-acidity from 59.0 mg/l to 20.3 mg/l. However, this would still not meet the 20 mg/l net-alkalinity TMDL target by 40.7 mg/l. Therefore, remediation efforts by the Raccoon Creek Partnership will focus on reducing acid loads to Raccoon Creek since recovery in East Branch at the current time is not likely.

The EB160 tributary represents drainage from underground mines located along State Route 56. The EB190 and EB210 tributaries represent drainage from partially reclaimed surface mines along Laurel Run and Sanner Road. The Vinton Soil and Water Conservation District (SWCD) is currently implementing an Ohio EPA 319 grant and ODNR Division of Mineral Resources Management funded acid mine drainage treatment project in East Branch. The project assessed water quality and determined sources of AMD in EB210, EB190, and EB160 and prioritized thirteen AMD sources or tributaries

for treatment or reclamation within those three subwatersheds. The project was broken up into two phases for design and construction, with EB210 and EB160 scheduled for Phase I and EB190 scheduled for Phase II. Both Phases I and II were designed by ATC Associates and GAI Consultants, respectively, but due to higher-than-expected costs only Phase I will be constructed in 2007. Phase II will be completed when funding is available.

Table 10. Action Table for East Branch 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
To reduce acid loading in EB210	<u>EB Phase I project:</u> EB200 – gob pile reclamation & steel slag leach bed (SLB) EB220 – SLB and wetland development EB240 – 3 SLB's EB260 – SLB	$1,001,583 construction funding from ODNR-DMRM Abandoned Mine Land program & EPA Section 319 program	2007	AMD treatments constructed, measured acid load reductions at project sites and in East Branch
To reduce acid loading in EB160	<u>EB Phase I project:</u> Create SLB at existing reclamation pond along SR 56 in EB161 tributary	Combined with EB210 as EB Phase I project	2007	AMD treatments constructed, measured acid load reductions at project sites and in East Branch
To reduce acid loading in EB190	<u>EB Phase II project:</u> EB191 – 1 SLB EB193 – 3 SLB's EB194 – 3 SLB's	$1,159,055 from ODNR-DMRM Abandoned Mine Land program	2009 - 2011	AMD treatments constructed, measured acid load reductions at project sites and in East Branch
Evaluate acid loads in EB120	Continue to monitor acid loads at EB120 as EB Phase I and II are completed	Staff support for sampling, water quality analysis from ODNR-DMRM lab	2008 - 2012	Measured acid loads, water quality interpretation

West Branch of Raccoon Creek

14 Digit HUC: 05090101-020-020
Location: Confluence with Raccoon Creek at River Mile 111.9
USGS Quadrangle: New Plymouth
Drainage Area: 22.59 square miles, 14,460 acres

Watershed Description

The West Branch of Raccoon Creek watershed is mainly located in Southeastern Hocking County with only the lower reaches near the confluence with East Branch in Vinton County, near the village of New Plymouth. West Branch is 8.1 miles long and has an average fall of 22.8 feet/mile. The West Branch has one large tributary, Honey Fork. Honey Fork drains 10.5 square miles, nearly half of the total West Branch drainage area. Honey Fork is 5.8 miles long and has an average fall of 18.1 feet/mile. The only other named tributary is Claylick Run, a tributary to Honey Fork that drains 1.78 square miles.

The watershed is mostly rural with small villages including Ilesboro, Mt. Pleasant, Orland, and New Plymouth. The land use of the watershed is mostly forest (96%) with agricultural lands, mostly pasture and hay fields, located in the main stream valleys of West Branch and Honey Fork. Coal mining has occurred exclusively by surface or strip mining techniques. Surface mines in the watershed are primarily ridge top surface mines scattered throughout the basin and have been mostly reclaimed. The exceptions are some abandoned surface mine sites on the western watershed boundary with Brushy Creek, near the village of Orland. These un-reclaimed ridge top sites still contain gob/spoil piles and acidic ponds.

Water Quality

Biological

Both the West Branch of Raccoon Creek (09-575) and Honey Fork (09-576) have been designated as WWH. West Branch is in non-attainment of WWH based on data from two locations, RM 0.2 to RM 5.7. Metals from AMD, livestock, mining, and channelization are listed as possible causes of impairment. Honey Fork (RM 0.5/1.5) is in partial attainment of its WWH designation and is impaired by habitat/sedimentation. Comparison of biological data over time at three surveyed sites shows no trend of improvement or degradation with IBI and ICI scores remaining fairly consistent over the past decade.

Table 11. Biological Data for West Branch and Honey Fork

Streams	River Mile	Year	IBI	ICI	QHEI	Causes
West Branch	0.2	1995	27	38	62	Mn, Zn, from AMD
		1996-2000	24	38/Fair	58	Livestock/Mining/Channelization
		2005	30	N/A	59	Not Available
	5.7	1995	22	Fair	54	Mn, Zn, from AMD
		1996-2000	24	38/Fair	58	Agriculture/Mining/Riparian
		2005	N/A	N/A	68	Not Available
Honey Fork	0.5/1.5	1999-2000	30	F	76	Habitat/sedimentation
		2005	34	N/A	77	Not Available

Physical

No dams have been identified on West Branch or Honey Fork, except for beaver dams which can be numerous in some areas. Channelization is not evident in reaches sampled or evaluated, or channels have recovered from past channelization for agricultural purposes. Although the majority of the floodplain area is either forested or serves as hay/row crop production, there are two known locations, at the mouth of West Branch and the mouth of Honey Fork, where cattle have access to the stream. The majority of both West Branch and Honey Fork appear to have some degree of riparian vegetation, but there are areas where the riparian vegetation is narrow.

QHEI data exists for four locations in the West Branch watershed as collected in 2005. Honey Fork RM 0.5 and West Branch RM 5.7 meet and exceed the target QHEI score of 60. West Branch RM 0.2 is only short of the target score by one point, which is due to narrow riparian vegetation and cattle access to the stream causing increased bank destabilization.

Chemical

The Raccoon Creek Headwaters AMDAT Plan (Rice 2002) ranked the West Branch of Raccoon Creek fifth on the priority AMD abatement and restoration list. The TMDL for the Upper Basin Raccoon Creek (Ohio EPA 2003) determined that AMD was a major cause of impairment to West Branch and modeled the mouth of West Branch (WB010) as a net-alkalinity target. WB010 is a long-term monitoring station for the Raccoon Creek Partners and has the most extensive data set within the West Branch. This modeling showed the mouth of West Branch with a net-acidic cumulative concentration of 20.2 mg/l, deviating from the 20 mg/l net-alkalinity target by 40.2 mg/l. The mouth of West Branch had the third highest deviation from the net-alkalinity target of the seven modeled stream segments in the Upper Raccoon Creek TMDL (Ohio EPA 2003). Data from the last four years shows pH ranging from 6.23 to 6.88 at WB010 with only the most recent

sample in 2005 above the 6.5 Ohio EPA warm-water habitat criterion (Figure 10). Although WB010 is typically net-alkaline, two sampling events in March and November of 2000 found acidic conditions as reported in the 2002 Raccoon Creek Headwaters AMDAT plan. This episodic net-acidic condition was measured during higher flows (> 22 cfs), which correlates with increased mine drainage runoff from abandoned and reclaimed surface mines in the watershed. More recent water quality data (2002 – 2006) indicates that WB010 is still typically net-alkaline, although only one of four samples (during extremely low flow) met the 20 mg/l net-alkalinity target established by the Upper Basin Raccoon Creek TMDL (Ohio EPA, 2003).

Metals associated with mine drainage such as iron and aluminum were analyzed at WB010 (Figure 11). In general, metal concentrations at WB010 are low with respect to other more severely AMD impacted streams in the Raccoon Creek Headwaters basin. Iron concentrations at WB010 average 0.65 mg/l, which is below the 1 mg/l USEPA criterion continuous concentration. Aluminum only exceeded the US EPA maximum criterion concentration of 0.75 mg/l during one sample in August of 2004. The 2004 sampling event was during an extremely low-flow event (1 cfs). In contrast to net-alkalinity and flow trends described above, metal concentrations appear to be elevated during extreme low flow events. Sulfate concentrations are typically below the 250 mg/l Ohio EPA criterion for WWH with the exception of the November 2000 sample (412 mg/l) which was the most acidic condition measured at WB010. Variability in the data is likely caused by changes in AMD loading to West Branch from surface mines, as linked to seasonal and event-based precipitation variability.

Figure 10. Net-Alkalinity and pH Data for the Mouth of West Branch (WB010)

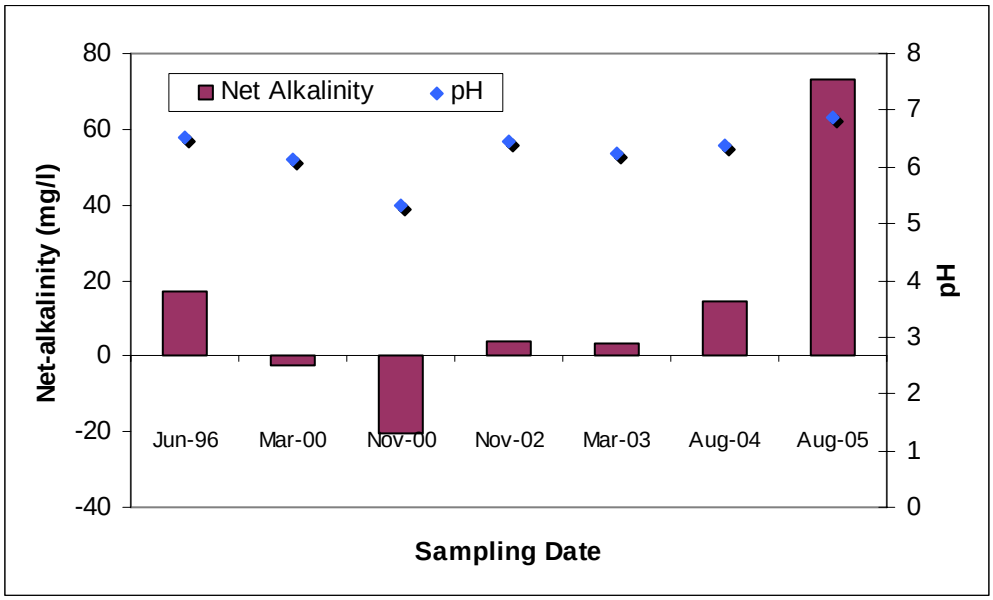
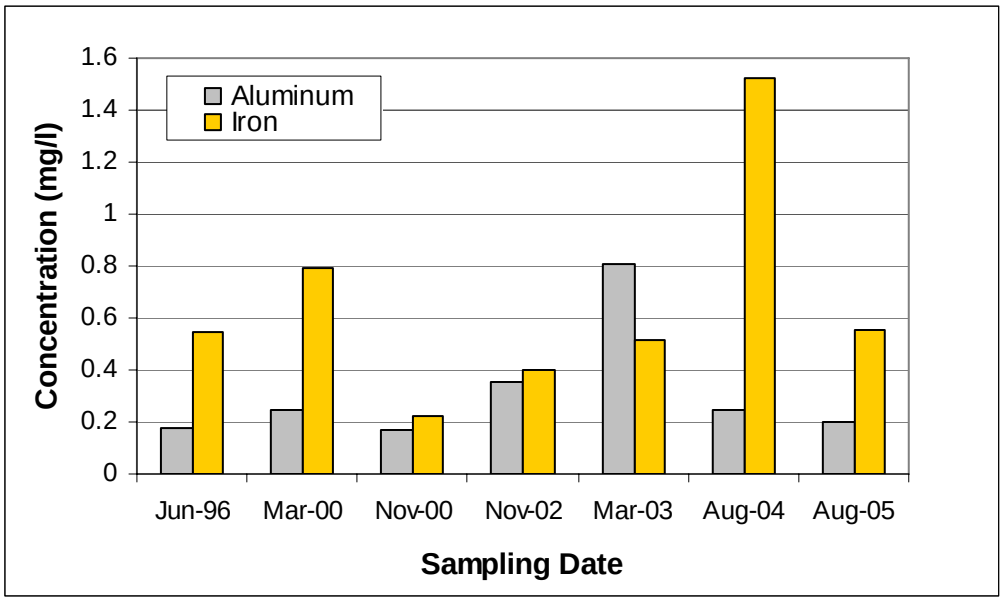


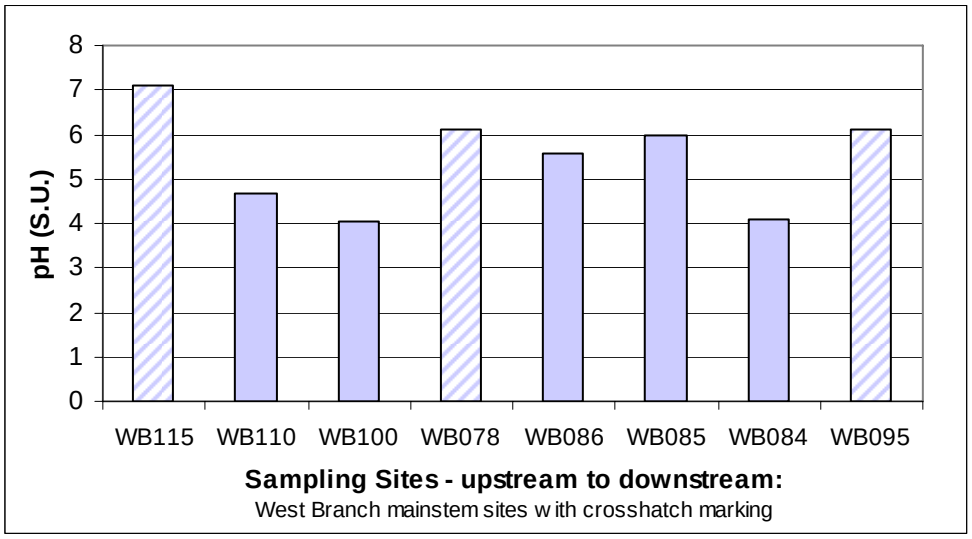
Figure 11. Iron and Aluminum Concentrations at the Mouth of West Branch (WB010)



Data at other stations along the mainstem of West Branch, although sparse, indicate more severe AMD impairments in the middle and uppermost reaches of West Branch coinciding with increased surface mines. The most prevalent AMD sources identified and measured for the 2002 Raccoon Creek Headwaters AMDAT study are located in unnamed tributaries from the SR 56 crossing (WB050 – RM 2.0) to the bridge crossing at Ilesboro Road (WB 115 – RM 5.7). Recent data on the West Branch at SR 93 crossing (WB095 – RM 4.1) shows very little alkalinity present with a net-alkaline concentration of only 2.76 mg/l and a pH of 6.16 during a low flow sample in August of 2006. However, total iron and aluminum concentrations at WB095 were well below established criterion with measurements of 0.12 and 0.14 mg/l for aluminum and iron, respectively. At WB115 (the Ilesboro Road bridge crossing) on the same day, AMD impacts were less apparent, with a net-alkalinity concentration of 18.3 mg/l and a pH of 6.38. Data in 2000 does show mild AMD impacts upstream of WB115, specifically at WB170 but water quality impacts do not appear to be severe.

In addition, recent reconnaissance studies at several unnamed tributaries in close proximity to the WB100 tributary show several abandoned mine sites that are leaching AMD into West Branch through a number of unnamed tributaries. WB110, WB086, WB085, and WB084 have all been identified as contributing AMD to West Branch. The four AMD tributaries range in average pH from 4 to 6 (Figure 12). The impact of WB110 and WB100 on West Branch is evident as the average pH value decreases an entire point from WB115 to WB078. Additional AMD inputs from WB086, WB085, and WB084 contribute enough acidity to offset other non-AMD impacted streams from buffering West Branch and raising pH.

Figure 12. West Branch pH Data from February 2006 – January 2007



Eight streams/sites were identified during 2002 AMDAT sampling as net-acid loaders to West Branch during at least one sampling event: WB050, WB060, WB070, WB080, WB100, WB110, WB130, and WB170. All eight sites are unnamed tributaries to West Branch. Four specific tributaries or AMD sources were identified as the main cause of AMD impairment to West Branch and are targeted for restoration by the Raccoon Creek Partnership as identified below. WB100 is the largest acid loader to West Branch with over 200 lbs/day and WB070 is the second highest loader with 124 lbs/day. However, WB070 has not been sampled since 2000. Sites WB084 and WB086 were only sampled in August of 2006 when flow was negligible so loadings could not be calculated. Water samples and field chemistry indicate the presence of AMD, which is seasonal and needs to be sampled during winter and spring to determine acid loads to West Branch.

Table 12. Acid Loading for Priority AMD Restoration Tributaries in West Branch

AMD Tributary #	Source Area	Acid Loading (lbs/day)
WB050	Unreclaimed 6 acre gob pile near village of Orland	48
WB060	Unreclaimed surface mine southeast of Orland; strip mine ponds	99
WB070	Reclaimed surface mine at Mt. Pleasant	124
WB084	53 acre unreclaimed surface mine; gob pile and strip mine ponds	NA
WB086	Same source as WB084	NA
WB100	51 acres of unreclaimed surface mine; gob piles and strip mine ponds	219
WB110	Same sources as WB100	36

Problem Statement

The West Branch of Raccoon Creek and the Honey Fork tributary are not attaining their designated aquatic life use of WWH. According to the 2002 Ohio EPA 303(d) list the major cause of impairment for West Branch is metals and for Honey Fork siltation. The 2002 Upper Basin Raccoon Creek TMDL modeled a net-alkalinity value of -20.2 mg/l at the mouth of West Branch which does not meet the target of 20 mg/l. AMD is prevalent in West Branch, with acidity, iron, and aluminum impacting the majority of the mainstem. Habitat impairments from a lack of riparian, bank instability and erosion, channel sedimentation, and livestock access are also evident in both West Branch and Honey Fork and could limit recovery from AMD abatement if not addressed.

Goals

1. To treat and abate acid mine drainage in eight priority AMD tributaries in the West Branch watershed.
2. Improve riparian habitat in the watershed where necessary to improve habitat and reduce bank erosion.
3. Determine possible causes of non-attainment in Honey Fork since QHEI meets target and AMD has not been documented as source of impairment.

Action Plan

The goal of all remediation activities at each site would be to eliminate all acid loading to West Branch if possible, although complete acid loading reduction from AMD sources may not be necessary to meet the net-alkalinity target at the mouth of West Branch or to promote biological recovery in West Branch.

Table 13. Action Table for West Branch 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
To reduce acid loading by 526(+) pounds into West Branch	AMD treatment or abatement at WB050, 060, 070, 084, 085, 100, & 110	$500,000 + from ODNR-DMRM Abandoned Mine Land program, EPA 319 program, others…	2010 - 2015	Measured acid load reductions at project sites and in West Branch
Identify all sites where riparian enhancement is needed	Conduct geomorphic and habitat data surveys	Student(s) to collect data	2008 – 2009	Priority site list for riparian enhancement sites completed
Determine sources of impairment to Honey Fork	Collect additional water quality and habitat data	Ohio EPA sampling and staff assistance	2010 - 2011	Causes and sources of impairment reported

Raccoon Creek Below West Branch to Above Brushy Creek

14 Digit HUC: 05090101-020-030
Location: Raccoon Creek Mainstem, River Miles 103.0-111.9
USGS Quadrangle: Zaleski, Mineral, New Plymouth, Union Furnace
Drainage Area: 10,417 Acres, 16.28 Sq Miles

Watershed Description

This sub-watershed begins at river mile (RM) 111.9 (the confluence of East and West Branches) and flows southward 9 miles until it arrives at the confluence point with Brushy Creek (RM 103.6). This basin, considered the headwaters of mainstem Raccoon Creek, encompasses 16.28 square miles of drainage (not including East and West Branch) and will be referred to as the "Above Brushy Creek" watershed. Land use is 95% wooded and 5% agricultural/urban. There are both named and unnamed tributaries within this drainage. Two Mile Run is the largest at approximately 2.77 miles long and with a drainage area of 4.99 square miles. Rocky Branch and Mitchell Hollow are the only other named tributaries within this basin. Rocky Branch is 1.44 miles in length and drains into Raccoon Creek from the northwest at RM 108.1. Mitchell Hollow is almost one mile in length (0.96 miles) and drains into Raccoon Creek from the north at RM 104.83. It drains the eastern edge of the Pumpkin Ridge reclamation area and therefore contributes a substantial amount of AMD into Raccoon Creek (Rice 2002). The vast majority of the above Brushy Creek basin is located in northeastern Vinton County; a very small section of the northeastern tip of the basin is located in Hocking County.

Water Quality

Biological

Historically, Ohio EPA has designated Raccoon Creek in the entire Headwaters11-digit HUC (RM 85.9 – 11.19) as Limited Resource Water (LRW). This LRW designation is due to pH and metals associated with AMD. The 2003 Upper Basin TMDL suggested upgrading that status to WWH, and its attainment status as "non-attaining". Two Mile Run, a tributary to Raccoon Creek in this reach is in partial attainment of its WWH designation according to 1995 data.

Biological analysis by Ohio EPA in 1995 characterized the Above Brushy Creek section with macroinvertebrate communities of low abundance and taxa richness, including a complete absence of mayflies (Ephemeroptera). Fish presence was isolated to only a few hardy species with low abundance and below-average weight levels. Most recent fish data collected in 2005 by the Midwest Biodiversity Institute documented continued impaired conditions with an IBI of 22 at RM 111.9 (MSBC010) and an IBI of 34 at RM 106.9 (MSBC100) in 2005. Both sites received qualitative macroinvertebrate rankings of

"moderately good". This indicates a slightly better biological condition at the lower end of this reach of Raccoon Creek than the upper reach.

Table 14. Biological Data for Raccoon Creek Below West Branch to Above Brushy Creek

Streams	River Mile	RC Site ID	Year	IBI	Miwb	ICI/QUAL	MAIS*	QHEI
Raccoon Creek	111.9	MSBC010	2005	22	2	MG	8	59.5
							9	
	109.1/108.9	NA	1995	18	1.7	14		60
	104.6	MSBC100	2005	34	8	MG		58.5
							9	
Two Mile Run	0.1	MSBC020	1995	28	NA	G		63

Physical

No dams have been identified on Raccoon Creek or Two Mile Run, except for beaver dams which can be numerous in some areas. Channelization is not evident in reaches sampled or evaluated. The majority of the floodplain is undeveloped with a few residential properties and some hay fields or pasture, although limited overall. The riparian corridor is typically wide, although there are a few locations where it is narrow because of agricultural practices.

The 2005 QHEI scores for mainstem Raccoon Creek Above Brushy Fork and Two Mile Run were 59.5 and 58.5 at RM 11.9 and RM 104.6 respectively. Both QHEI sites are close to the target of 60 and should provide adequate habitat to support normal assemblages of aquatic life if chemical impairments were removed.

Chemical

This section of the Raccoon Creek is mostly impacted from AMD runoff from East Branch and West Branch upstream. MSBC010, a half mile downstream of East and West Branch (RM11.9), is severely impacted by AMD. The average net-alkalinity at this site since 2003 is 3 mg/l and the highest acidity concentration measured was 24 mg/l in February of 2007. The lowest pH measured was 5.9. Water quality tends to improve at the downstream monitoring location on Raccoon Creek, MSBC100 (RM 104.6) where the average net-alkalinity is 8.95 mg/l. Neither of the two monitoring locations meet the net-alkalinity target of 20 mg/l set by the 2003 TMDL or the USEPA pH standard of 6.5 – 9.0. In addition to acid loading from West Branch and East Branch, three additional tributaries within this basin were found to load acid into Raccoon Creek (Rice, 2002). All originate on the western side of Raccoon Creek in the Pumpkin Ridge area, which has been surface mined for coal and reclaimed. These tributaries include Mitchell Hollow (MSBC091), un-named tributary MSBC110, and un-named tributary MSBC120. Samples were collected for both a low flow event and a high flow event in 2000 (Table 15). MSBC120 had the highest average acid load with 165 lbs/day.

Table 15. 2000 Average Acid Loadings for AMD Tributaries in Raccoon Creek Above Brushy Creek Watershed

Tributary	Average Acid Load (lbs/day)
MSBC091	40
MSBC110	32
MSBC120	165

Two Mile Run has historically been considered an acid loader (317 lbs/day at MSBC025 in 1996). OEPA reported that although being 46mg/l net alkaline in 1995, Two Mile Run did show evidence of AMD with high sulfate levels (480 mg/l) and iron flocculent present in the stream. However, Rice (2002) determined that Two Mile Run has recovered, producing a net alkaline load of 760 lbs/day at MSBC020.

In summary, the entire Above Brushy Creek drainage was measured to be adding 6.1 mg/l of acid into the downstream Raccoon Creek watershed (OEPA, 2003). This score deviates from the 20 mg/l TMDL net-alkalinity target by a total of 26.1 mg/l.

Problem Statement

Raccoon Creek above Brushy Creek is currently in non-attainment of its recommended WWH designation. This section of Raccoon Creek is impacted from AMD and does not meet the TMDL target of 20 mg/l net alkalinity or the EPA standard for pH of 6.5 – 9.0. Two Mile Run is in partial attainment of its WWH status with a non-attaining IBI score.

Goals

1. To monitor water quality in this section of Raccoon Creek as AMD implementation occurs upstream in West Branch and East Branch.
2. Reduce acid loads from tributaries MSBC090, MSBC110, and MSBC120 in the watershed.
3. Reassess Two Mile Run to determine more current use attainment status.

Action Plan

For Raccoon Creek to recover biologically in this section of stream, acid abatement from East Branch and West Branch is necessary because they are direct acid loaders to Raccoon Creek at the headwaters of this section. In addition, abatement of the three AMD tributaries MSBC090, MSBC110, and MSBC120 is recommended to supplement acid load reductions from East Branch and West Branch.

Table 16. Action Table for Raccoon Creek Below West Branch to Above Brushy Creek 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
To reduce acid loading by 526(+) pounds into Raccoon Creek	AMD treatment or abatement with alkaline addition at MSBC090, 110, & 120	$500,000 + from ODNR-DMRM Abandoned Mine Land program, EPA 319 program, others.	2012 - 2015	Measured acid load reductions at project sites and in West Branch
Monitor water quality changes in Raccoon Creek	Continue long term monitoring program in Raccoon Creek Headwaters	Staff to collect data, sample collection and analysis support	2008 – 2015	Priority site list for riparian enhancement sites completed
Reassess use attainment status of Two Mile Run	Collect biological and habitat data at mouth of Two Mile Run	Ohio EPA sampling and staff assistance	2008 - 2009	Biological data collected and analyzed, use attainment updated

Brushy Creek (Fork)

14 Digit HUC: 05090101-020-040
Location: Confluence with Raccoon Creek at River Mile 103.6
USGS Quadrangle: Zaleski & Allensville
Drainage Area: 33.79 square miles, 21,624.5 acres

Watershed Description

Brushy Fork is listed as the official name of this 14-digit HUC watershed but is often referred to by the Raccoon Creek Partnership, locals, and other agencies as "Brushy Creek". It appears that Brushy Creek is a tributary to Brushy Fork, but mis-interpretation of this has led to the two names being used in the past. Brushy Creek will be used in this management plan for consistency with local terminology and existing watershed planning efforts.

Brushy Creek is located mostly in Vinton County with a small northernmost section in Hocking County. Brushy Creek is a fairly large tributary with a drainage area of 33.79 square miles. There are two named tributaries to Brushy Creek: Dunkle Creek and Siverly Run. Dunkle Creek drains into Brushy Creek at RM 4.1 and Siverly Run enters at RM 2.8. The Brushy Creek mainstem is 10.8 miles long and has a relief of 27.8 ft/mile. Land use in this basin is primarily wooded (94%) and agricultural/urban (4%), which likely takes into account reclaimed surface mines. The dominant bedrock for the western portion of the watershed and the major stream valleys is the Mississippian age formation. These formations do not have economical beds of coal and thus mining in the Brushy Creek watershed is limited to ridge tops on the eastern and northern boundary where Pennsylvanian bedrock formations exist.

Water Quality

Biological

Brushy Creek is severely impaired biologically from the effects of acid mine drainage. Both Ohio EPA and the Midwest Biodiversity Institute have collected biological data in Brushy Creek from 1996 to 2005 (Table 17). Brushy Creek (RM 0.4 – 9.1) was recommended to have its designated use lowered to WWH through the TMDL process (2003) and would be in non-attainment of that status. The cause of non-attainment is pH. Dunkle Creek (RM 0.7 – 0.9) is listed as WWH and is in partial attainment of that designated uses. The cause of non-attainment is listed as metals. Siverly Creek received an IBI of 40 in 1997 and a macroinvertebrate ranking of Good in 2000 by Ohio EPA but an aquatic life use status is not reported.

Table 17. Biological Data for Brushy Creek Watershed

Streams	River Mile	RC Site ID	Year	IBI	Miwb	ICI/QUAL	MAIS*	QHEI
Brushy Creek	0.4	BC010	2000	12	0	V. Poor		47
			2005	12	2	MG		51
		BC050	2001				2	
			2002				3	
			2003				4	
	7.9	BC098	2005	34				48.5
Dunkle Creek	0.7	BC020	1996	34				64
Siverly Creek	0.9	BC040	1997	40				67
			2000			G		

Physical

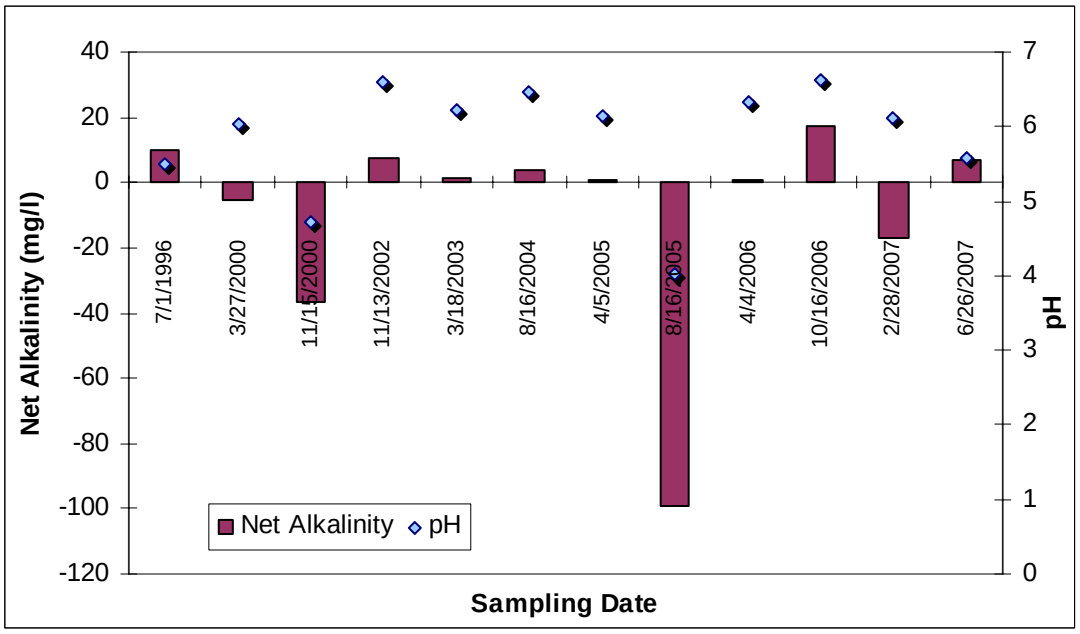
No dams, with the exception of beaver dams, have been documented in Brushy Creek or its principal tributaries. Channelization is evident in the lower 0.5 river miles before the confluence with Raccoon Creek. The stream appears to have been channelized and straightened for agricultural purposes (row crops and pasture) and poor QHEI scores reflect those conditions. Overall floodplain development is limited in the watershed and land use is mostly forested, hay fields, or pasture. Substrate from RM 7.9 to the confluence with Raccoon Creek is impaired by metal flocculent from mine drainage in the basin as well.

Habitat conditions in Brushy Creek are generally impaired according to QHEI scores. The Brushy Creek confluence sample (RM 0.4) was found to have a QHEI of 47 and 51 in 2000 and 2005 respectively. Physical stream channel degradation included poor sinuosity, a lack of riparian corridor, and poor riffle development. This section of Brushy Creek appears to have been straightened and channelized and cattle have unlimited access to the stream upstream of SR 328. At RM 7.9, a QHEI of 48.5 was recorded. Both Dunkle and Siverly Creek's QHEI scores attain the statewide target for WWH habitat of 60.

Chemical

Brushy Creek water quality varies between a net-acid and a net-alkaline loader to Raccoon Creek. Brushy Creek was found to be discharging 418 lbs/day of net alkalinity into the Raccoon Creek mainstem during the summer of 1996. However, in the spring and fall of 2000, Brushy Creek was loading 1,103 lbs of acid per day into Raccoon Creek. Unlike East and West Branch drainages, Brushy Creek's water quality problems are more severe under low flow conditions. Partially reclaimed surface mines in the basin have seeps that flow most of the year and are sometimes the only source of water during summer critical flow times. In August of 2005, the highest concentration of acidity was measured at BC010 of 99.2 mg/l (Figure 13). On this same date, the pH was measured at 3.74, too low to support aquatic life.

Figure 13. Net Alkalinity Levels at the Mouth of Brushy Creek (BC010), 2000-2006



All priority sources of AMD in the basin are concentrated along the eastern and northern borders of the watershed. The eastern ridge that separates Brushy Creek and Raccoon Creek is known as Pumpkin Ridge, which has been heavily surface mined for coal. Although most of the ridge is reclaimed under current mining laws, earlier pre-law contour surface mine tailings in the head of most hollows still generate highly acidic groundwater seeps. The ridge to the north separating Brushy Creek from West Branch has some similar AMD situations along with some un-reclaimed surface mines as well.

Table 18. Priority AMD Tributaries in the Brushy Creek Watershed

AMD Tributary	Source Area	Average Acid Loading (lbs/day)
BC060	Unnamed tributary from Pumpkin Ridge; partially reclaimed surface mine	349
BC070	Unnamed tributary from Pumpkin Ridge; partially reclaimed surface mine	204
BC090	Unnamed tributary from Pumpkin Ridge; partially reclaimed surface mine	188
BC110	Pumpkin Ridge and Mt. Pleasant partially reclaimed surface mines	930
BC150	Partially reclaimed surface mine at Mt. Pleasant	91

Both Dunkle Creek and Siverly Creek, which generally suffer much less from adverse effects of AMD, are in attainment of the net alkalinity target of 20 mg/l with scores of 32 mg/l and 31.5 mg/l, respectively, providing some buffering capacity to Brushy Creek.

Problem Statement

Brushy Creek is currently in non-attainment of its WWH designation for its entire length. The major cause for non-attainment is low pH from acid mine drainage. Brushy Creek was modeled to have a net-alkalinity concentration of -13.2 mg/l, which does not attain the net-alkalinity target of 20 mg/l set by the Upper Basin Raccoon Creek TMDL (Ohio EPA, 2003). The mainstem of Brushy Creek is severely impacted by AMD causing low pH and high metal concentrations. The source of AMD in the watershed is located mostly in Pumpkin Ridge area, an extensively mined ridge on the eastern border of the watershed.

Biological and use attainment data is outdated for Dunkle and Siverly Creek tributaries for an accurate assessment of their biological, habitat, and chemical quality.

Goals

TMDL modeling (Ohio EPA, 2003) indicates that if all AMD treatment projects suggested by the Raccoon Creek Headwaters AMDAT were implemented in the basin that the middle section of Brushy Creek could possibly meet the 20 mg/l net-alkalinity target and the lower section would exceed the target by over 20 mg/l. However, AMD source remediation or treatment in Brushy Creek is difficult because of the nature of AMD sources and the lack of fresh water for alkaline addition. Therefore, AMD remediation efforts by the Raccoon Creek Partnership will focus on implementing projects that will reduce acid loads to Raccoon Creek from Brushy Creek and meeting the 20 mg/l net alkalinity target at BC010 (mouth). Biological recovery of Brushy Creek is not foreseen in the near future unless new technologies or resources become available.

1. Reduce all acid loading into Raccoon Creek (from Brushy Creek by treating AMD from source tributaries BC060, BC070, BC090, BC110, and BC150).

2. Collect biological, habitat, and physical data for Dunkle and Siverly Creek.

Action Plan

Since AMD is the overwhelming pollutant in the basin it will be the focus of restoration activities in the near future. The 2002 Raccoon Creek Headwaters AMDAT suggested AMD treatment at six locations in Brushy Creek: BC060, BC070, BC090, BC111, BC113, BC114, and BC150. Sites BC111, BC113, and BC114 are all in the BC110 tributary. Open limestone channels (OLC) or slag lined channels were suggested for each at a total cost of $649,307. AMD in the basin is difficult to treat due to the sources being groundwater seeps in small hollows without much area for treatment. More recent treatment analysis by ODNR and consultants showed a strategically placed steel slag

leach bed or two was the best option for AMD neutralization in the basin. The Raccoon Creek Partnership is performing reconnaissance in the basin to identify clean sources of water and the best location for steel slag leach beds.

Table 19. Action Table for Brushy Creek 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
To reduce acid loading in Brushy Creek by 1,671 lbs/day	AMD treatment or abatement at BC050, 070, 090, 110, & 150	Estimated $500,000 + from ODNR-DMRM Abandoned Mine Land program, EPA 319 program, others.	2010 - 2015	Measured acid load reductions at project sites and in Brushy Creek
Determine current use attainment of Dunkle Creek	Collect and analyze fish, habitat, and macroinvertebrate data	Ohio EPA sampling and staff assistance	2009 – 2010	Use attainment status reported
Determine current use attainment of Siverly Creek	Collect and analyze fish, habitat, and macroinvertebrate data	Ohio EPA sampling and staff assistance	2009 - 2010	Use attainment status reported

Wheelabout Creek

14 Digit HUC: 05090101-020-050
Location: Confluence with Raccoon Creek at River Mile 97.4
USGS Quadrangle: Zaleski, Mineral, McArthur, & Vales Mills
Drainage Area: 7,612 acres, 11.89 square miles

Watershed Description

Wheelabout Creek is the southernmost 14-digit HUC within the 11-digit Raccoon Creek Headwaters. Wheelabout Creek is approximately 1.6 miles long, has a gradient of 10.58 ft/mile, and drains into Raccoon Creek at river mile (RM) 97.4. It is located entirely within Vinton County and flows in a "U" shape which is where it gets the Wheelabout name. The creek begins with Jones and Reeves Hollow a few miles east of the village of Zaleski. It then flows southwest where Hoagtand Hollow enters from the north. Three quarters of a mile further downstream an unnamed tributary from the south enters and the creek turns northward. It then flows northward for approximately two miles along SR 278 until its confluence with Raccoon Creek. The large unnamed tributary that enters from the south along SR 278 also flows in a "U" shape, creating an unusually shaped watershed.

The majority of the watershed is property of Zaleski State Forest with intermittent private property. Land use is 99% wooded and 1% agricultural/urban. Wheelabout Creek does contain one mapped surface mine (159 acres) along SR 278 just north and west of the town of Prattsville.

Water Quality

Biological

Ohio EPA has only sampled Wheelabout Creek in one location for fish, habitat, and macroinvertebrates. This location is RM 0.6, which was sampled in 1999 and 2000. This site scored an IBI of 28 and the Qualitative macroinvertebrate sample was evaluated as "good". Wheelabout Creek was originally designated as EWH but the Upper Basin TMDL suggested lowering the designated use to WWH based on the 1999 and 2000 biological data. Wheelabout Creek is in partial attainment of WWH based on this data.

Physical

Two QHEI scores in 2000 and 2005 for Wheelabout Creek at RM 0.6 were 67. Although this is a considerably high score for both years, it was stated in 2000 that loose sand in the stream resulted in poor habitat adversely affecting biological communities and this stream was listed on OEPA's most recent 303(d) list (1998- 2006) for sediment/siltation. In 2001 and 2002, QHEI scores were calculated for different river miles of an unnamed

tributary to Wheelabout Creek; these RM (1.5 and 2.2) had corresponding scores of 54 and 63, respectively.

No dams were recorded on Wheelabout Creek or any of its tributaries, except for Beaver dams which can be numerous. The creek appears to have a deep and wide channel but does flood frequently indicating good floodplain connection. Wheelabout Creek's unique drainage pattern is due to the geologic setting. When analyzing digital elevation models it is apparent that the current drainage pattern differs from the pre-glacial drainages. Part of the mainstem of Wheelabout Creek and the southern unnamed tributary appeared to have flowed in a southern direction before glacial influences changed the drainage to flow north into Raccoon Creek. These drainage changes are significant in channel development and need to be further studied for better understanding.

As part of the Upper Basin of Raccoon Creek Sediment TMDL (McCament, 2007) both Rapid Geomorphic Assessment (RGA) and suspended sediment was collected at RM 0.6. Suspended sediment was collected using USGS single stage sediment samplers at ½ the channel height for two high flow events: 1-10-06 and 1-26-06. Suspended sediment concentrations were calculated, flow was estimated, and a suspended sediment load was estimated. Wheelabout Creek's suspended sediment load for these two events was less than the reported regional yield at bankfull flow. The channel instability index (RGA) scored a 23, indicating relative channel instability (compared to the rest of the Upper Raccoon Creek Basin; TMDL target score is 15 or less) and a channel evolution stage of IV (Simon and Downs, 1995), exhibiting stream bank instability along 76 to 100% of both banks. Further study on the sedimentation and sediment loads in Wheelabout Creek is needed to determine if sediment is indeed the limiting factor for meeting WWH and to determine possible action steps.

Chemical

Wheelabout Creek has generally been considered a net alkaline producer to Raccoon Creek. Wheelabout Creek has only been sampled at MSLH140 three times since 1996. The 1996 sample showed a net alkaline load of 88 lbs/day with a net alkalinity of 23 mg/l while a 2000 sample showed a net-acid load of 320 lbs/day and a net-acid concentration of 5.5 mg/l. The acidic event was measured at over 10 cfs, which would be considered a high flow event - near the annual mean daily flow for the watershed. Raccoon Creek monitoring stations do not indicate adverse effects from acid loading at Wheelabout Creek however, with no significant decrease in net-alkalinity downstream. The assumption is that during drier periods of the year, water is not draining from the reclaimed surface mines whereas during high flow it is; however, during high flow it is also assumed that the Raccoon Creek mainstem is able to absorb and dilute the acidic waters due to its own high river flow.

Problem Statement

Wheelabout Creek is currently in partial attainment of its suggested WWH designated use. Wheelabout Creek cause of impairment is listed as sediment, although AMD may be

an additional stressor. Wheelabout Creek was not listed as a priority for AMD abatement in the 2002 AMDAT plan because of its relative impact to Raccoon Creek compared to other AMD streams in the watershed.

Goals

1. Collect additional biological data in Wheelabout Creek to determine current aquatic life use attainment.
2. Collect chemical data to further assess the presence/absence of AMD in the watershed.
3. Perform a geomorphic assessment of the watershed to determine the cause and extent of instream sedimentation and to determine if channel instability is local or widespread in the basin.

Action Plan

No action plan for AMD in Wheelabout Creek currently exists due to its low priority compared to other sites within the Raccoon Creek Headwaters watershed. A reevaluation of the AMD impact will be necessary as other AMD projects in the watershed are implemented. Sediment impacts appear to be a major cause of non-attainment and need to be further assessed to develop an action plan to address the impairment.

Table 20. Action Table for Wheelabout Creek 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
Monitor water quality in Wheelabout Creek	Chemical data collection at MSLH140 twice yearly	Staff and volunteers for data collection, ODNR-DMRM sample analysis	2008 - 2010	Water quality data entered into online database, annual report
Monitor biological changes in Raccoon Creek	Biological data collection at MSLH140	Ohio EPA or ODNR-DMRM or ODNR-DOW assistance	2009	Biological data entered into online database, use attainment status determined
Evaluate channel instability and channel sedimentation	Perform geomorphic assessment of Wheelabout Creek and tributaries	Staff time, Ohio University geomorphology assistance	2009 - 2010	Channel data collected, analyzed, and reported; remediation alternatives evaluated

Raccoon Creek Below Brushy Fork to Above Hewett Fork

14 Digit HUC: 05090101-020-060
Location: Raccoon Creek, River Miles 103.6 – 89.54
USGS Quadrangle: Zaleski & Mineral
Drainage Area: 12,414 acres sq., 19.4 miles sq.

Watershed Description

While the official NRCS name for this 14 digit HUC is "Raccoon Creek Below Brushy Fork to Above Hewett Fork," for purposes of this section, the HUC will simply be referred to as "Raccoon Creek Mainstem Below Brushy Creek". This drainage includes the mainstem of Raccoon Creek below its confluence with Brushy Creek at river mile (RM) 103.6 to just above its confluence with Hewett Fork at RM 89.54. This section of Raccoon Creek flows through the town of Zaleski (RM 98.3) and near Lake Hope State Park. The drainage is contained entirely in Vinton County and because of Zaleski State Forest and Lake Hope State Park the land cover is 95% wooded. Most of the remaining 5% is agricultural or urban. A large 72 acre wetland, referred to as the Zaleski Wetland exists adjacent to Raccoon Creek just downstream of the village of Zaleski and across SR 278 from the Zaleski State Forest headquarters.

Two other 14-digit HUCs flow into the main stem of Raccoon Creek within the confines of this 13.52 mile stretch: Wheelabout Creek and Sandy Run, which are addressed in separate sections. Other direct tributaries to Raccoon Creek include an unnamed tributary at RM 98.96 that drains the Austin Powder facility (OEPA NPDES permit # OIF00003) of which part of their WWTP system drains into and three small streams (Bolster, Coalmont, and Mine Hollow) northwest of Zaleski.

Water Quality

Biological

According to Ohio EPA 1998 3003(d) list this section of the mainstem of Raccoon Creek is listed as Limited Resource Water (LRW) – AMD. A classification given to streams impaired by AMD for which recovery to WWH is not expected. Raccoon Creek was in full attainment of this designation with IBI scores of 22 at RM's 99.7 and 98.4. The Ohio EPA 2003 Upper Basin Raccoon Creek TMDL suggested raising the designated use to WWH because of noted improvements to aquatic life. Raccoon Creek would still be in non-attainment of WWH in this section, but raising the goal of restoration to WWH seemed reasonable. More recent data in 2004 and 2005 shows even more improvements to fish populations. At RM 102.1 which is at the upper reach of this section of Raccoon Creek, an IBI of 34 and Miwb of 7 were recorded in 2005. A MAIS score of 11 (Poor) was recorded in 2006 at this site. Although still impaired, it shows recovering biological conditions in the Raccoon Creek watershed. At RM 90.0 which is the lower end of this

reach, an IBI of 44 in 2004 and 48 in 2005 was recorded, which meets the WAP ecoregion criteria for WWH (44 for wading site). In general, biological integrity improves from the upstream to downstream reach as shown in Figure 7 (page 32) in Section I of this report.

Table 21. Biological Data for Raccoon Creek Below Brushy Fork to Above Hewett Fork Watershed

Streams	River Mile	RC Site ID	Year	IBI	Miwb	ICI/QUAL	MAIS*	QHEI
Raccoon Creek	102.1	MSLH020	2005	34	7	24		52
			2006				11	
	99.7/101.2	NA	1995	22	5.4	18		61
	98.4/98.3		1995	22	4.9	18		49
	92.3	MSLH130	1995	35	7	36		69
	90	MSBM004	2004	44				60.5
			2005	48				66.5

Physical

No dams have been identified on West Branch or Honey Fork, except for beaver dams which can be numerous in Raccoon Creek and many of its tributaries. Channelization is not evident in reaches sampled or evaluated. The riparian corridor in this reach of Raccoon Creek is exceptional with the majority of the floodplain owned by the Zaleski State Forest. Riparian vegetation is only narrow in a few small locations in the upper reaches of this section of Raccoon Creek. The floodplain is almost entirely undeveloped and floodplain forests are well developed and numerous in this section as well as wetlands and vernal pools. Because of extensive riparian vegetation and floodplain forests, this section of Raccoon Creek is loaded with large woody debris that provides cover and substrate for aquatic life.

According to 2005 QHEI scores at RM 102.1 (52) and RM 90.0 (60.5), habitat is better in the downstream. RM 102.1 is on private property with adjacent floodplain agricultural use and is more impacted by AMD from Brushy Creek directly upstream. RM 90.0 is in Zaleski State Forest.

Chemical

Three mainstem long term monitoring sites have been established in this reach by the Raccoon Creek Partnership: MSLH020 (RM 102.1), MSLH130 (RM 92.3), and MSBM004 (RM 90.0) that corresponds with biological monitoring sites listed in Table 21. Net-alkalinity concentrations meet the 20 mg/l target on two of four samples taken in 2006 and 2007 (Figure 8, Section I (page 33)). The target was met during the two low flow conditions and did not meet during the two higher flow conditions. This relates to increased mine drainage from surface mines with precipitation in the upstream watershed. All three sites have been measured as net-alkaline since 2002 except for the February 2006 sample which showed net-acidic conditions in Raccoon Creek throughout the whole

watershed. Average net-alkalinity and pH values for Raccoon Creek monitoring sites are displayed in Table 22, which shows that average net-alkalinity concentrations and pH do not meet established targets/standards. Average pH data at all three sites is just below the standard of 6.5 established by USEPA.

Table 22. Net-alkalinity and pH in Raccoon Creek Below Brushy Creek to Above Hewett Fork Watershed (2003 – 2007)

Site	Average Net-alkalinity (mg/l)	Average pH	Years of Data Collection	# of Samples
MSLH020	10.32	6.4	2004 – 2007	7
MSLH130	10.56	6.44	2003 – 2007	8
MSBM004	7.49	6.49	2006 – 2007	4

An AMD source does exist in Mine Hollow and an adjacent unnamed tributary but are neutralized and naturally treated by the Zaleski wetland before entering Raccoon Creek. An Ohio University Hydrology class studied the hydrology and chemistry of the wetland for a class project in September of 2004. The two AMD sources load over 500 lbs/day of acidity into the Zaleski wetland according to one sample in 2004. Water chemistry data concluded that the wetland reduced concentrations of acidity by 89% and reduced iron by 31%. The wetland was a net-alkaline loader to Raccoon Creek during the sampling event. If this wetland were to be removed or drained, AMD from Mine Hollow would likely impair this section of Raccoon Creek again. Wheelabout Creek and Sandy Run, larger tributaries to Raccoon Creek in this reach, are considered to be alkaline and provide some buffering to the stream.

Figure 14. Picture of the Zaleski Wetland, Vinton County

Goals

1. Continue long term monitoring at the three established Raccoon Creek sites to document any changes as AMD treatment activities continue upstream.
2. Support Zaleski State Forest in any effort to preserve the Zaleski wetland and other wetlands in the watershed that are critical for good water quality in Raccoon Creek.

Problem Statement

As confirmed by the 1997 OEPA and 2002 AMDAT reports, Raccoon Creek is not meeting net-alkalinity targets or the USEPA pH standard between RM 103.6 and 89.54.

Action Plan

Water quality impairments in this watershed are primarily due to upstream AMD discharges at Brushy Creek, Pumpkin Ridge (Mitchell Hollow and its associated tributaries), East Branch, and West Branch. AMD abatement and treatment of these upstream sources is recommended to improve water quality in this reach of Raccoon Creek. It is recommended that continued monitoring be done at all three established long term monitoring sites on Raccoon Creek to track changes in water quality.

Table 23. Action Table for Raccoon Creek Below Brushy Creek to Above Hewett Fork 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
Monitor water quality changes in Raccoon Creek	Chemical data collection at MSLH020, LSLH130, and MSBM004 twice yearly	Staff and volunteers for data collection, ODNR-DMRM sample analysis	2008 - 2012	Water quality data entered into online database, annual report
Monitor biological changes in Raccoon Creek	Biological data collection at MSLH020, LSLH130, and MSBM004	Ohio EPA or ODNR-DMRM or ODNR-DOW assistance	2010	Biological data entered into online database, 2011 progress report

Sandy Run

14 Digit HUC: 05090101-020-070
Location: Confluence with Raccoon Creek at River Mile 92.52
USGS Quadrangle: Mineral, Zaleski, McArthur, and Vales Mills
Drainage Area: 7,366 acres, 11.51 square miles

Watershed Description

Sandy Run is a tributary to Raccoon Creek at RM 92.52 from the north. Sandy Run is 6 miles long and has a gradient of 27.5 feet per mile and runs along SR 278. The mainstem of Sandy Run is dammed at RM 0.3 to create the 120 acre Lake Hope. Lake Hope is part of the ODNR owned and operated Lake Hope State Park (2,983 acres). Little Sandy Run is a smaller tributary which runs south and east on the western side of Lake Hope; it enters Sandy Run just downstream of the Lake Hope spillway. Little Sandy Run is 1.8 miles long and has a gradient of 41.6 feet per mile. There are fourteen named hollows in the small watershed.

Lake Hope State Park (2,983 acres) and Zaleski State Forest constitute almost the entire land ownership of the watershed. Land use within this sub-watershed is almost entirely (99.7%) wooded. Sandy Run watershed does contain 226 acres of abandoned underground coal mines in the headwaters and in Big Four Hollow that were abandoned between 1965 and 1968.

Water Quality

Biological

Sandy Run is designated as WWH but according to 2000 biological data is in non-attainment with an IBI of 18 and a QHEI of 56.5. Macroinvertebrates were not collected by Ohio EPA in Sandy Run. The 2002 Raccoon Creek Headwaters reported macroinvertebrate sampling in Sandy Run during 2002 at RM 2.7 (King Hollow Road). Three separate samples were collected at three different times: spring, summer, and fall; each with respective pH values of 5.6, 5.72, and 5.22 (indicating net acidity). Sandy Run was described as being "moderately impacted" by AMD. Results showed abundance over 600 and genera of 15 during a summer 2000 sample. Results indicated low to moderate AMD impacts based on organisms collected.

Lake Hope is designated as Exceptional Warmwater Habitat (EWH) and is considered in partial attainment. In regards to the biological communities of Lake Hope, Hollenkamp (2004) completed a graduate thesis in 2004 where she found that excessive metal concentrations due to Sandy Run AMD runoff had adversely affected biological communities; resultant species assemblages were typified by tolerant species such as Dipterans. Also the relegation of acid-sensitive (intolerant) species such as Amphipods to

deep zones is also indicative of AMD effects. ODNR Division of Wildlife lists fishing forecasts for largemouth bass, red-ear sunfish, bluegill, and channel catfish with an outlook of "good". Saugeye populations are relatively low compared to other Southeast Ohio lakes and the fishing outlook is considered "fair". ODNR Division of Wildlife implemented a stocking program for largemouth bass and channel catfish due to water quality improvements that would support a fishery in the lake (ODNR-DOW, 2007).

Physical

As already mentioned, Sandy Run is dammed at RM 0.3 for Lake Hope. Sandy Run is affected by the backwaters of Lake Hope upstream to about RM 2.4. Sandy Run's riparian corridor and floodplain is completely forested.

Sandy Run was listed on Ohio EPA's 1998-2006 303(d) list for heavy siltation impacts. Most recent QHEI scores collected in 2005 at RM 2.6 and RM 4.8 scored a 58 and 70.5. River mile 2.6 is two points below the QHEI target score of 60 and RM 4.8 is more than ten points over the target. As implied by the name, substrates are dominated by sand and embeddedness was "extensive," and substrate was listed as "silt heavy" for RM 2.6 QHEI. The basin has undergone historical denudation related to underground coal mining and iron furnace (Hope Furnace) operation which likely increased sedimentation to the stream. Since these mineral resource extraction activities, the basin has completely reforested and new sources of sediment are relatively absent.

Chemical

There are only 4 data collection points within this watershed: MSLH100, MSLH120, MSLH121, and MSLH122. MSLH100 is found at Little Sandy Run approximately 0.4 miles upstream of its Lake Hope outflow. MSLH120 is at the Lake Hope outflow just above the Little Sandy Run confluence. MSLH121 is along the Sandy Run mainstem approximately 0.2 miles above Lake Hope. And lastly, MSLH122 is on a tributary called Big Four Hollow just upstream of its confluence with Sandy Run at approximately RM 4.9. Big Four Hollow suffers from AMD impacts as several abandoned mines complexes are situated along its headwaters. Mine complex Vn-88 has had a mine seal in place since 1979.

Listed chemical impairments for Sandy Run are pH and metals. Very little chemical data has been collected in Sandy Run since 1996 (Hughes) which showed acidic conditions at both MSLH121 and MSLH122. The study focused on the long term effects of a 1979 completed mine seal for mine complex 88. This mine seal has had the long term effect of reducing AMD runoff to Big Four Hollow; up to 57% less than at previous levels. Related water quality in Big Four Hollow has improved since 1987 as net acidity has decreased by 17 mg/l and pH has risen by 0.8. Although the improvement effects were somewhat diluted downstream, 19% less AMD was observed at RM 3.8 while RM 2.7 also saw a reduction in acid and iron loading since 1971. Mine complex 47 was also found to be producing less acid but was attributed to natural attenuation of coal seams.

One additional field pH in 2003 was 5.63 at MSLH121 (RM 2.6) but no samples were collected.

Chemical sampling in 2000 for the Raccoon Creek Headwaters AMDAT (2002) documented Sandy Run (i.e. Lake Hope) as an acid loader to Raccoon Creek, which was contradictory to 1996 data showing Sandy Run (i.e. Lake Hope) as an alkaline loader to Raccoon Creek. Field pH's in 2003 and May 2007 at MSLH120 (downstream Lake Hope) were 6.84 and 6.04, indicative of slightly acidic waters. The May 2007 field sampling showed a decrease in pH from 6.90 upstream of Lake Hope in Sandy Run to a pH of 6.04 downstream of Lake Hope. This indicates the loss of alkalinity in the lake but the cause is unknown and needs further study.

Listed chemical impairments for Lake Hope are pH and metals. Hollenkamp (2004) assessed the bioavailability and metals concentrations in Lake Hope. Results showed that Lake Hope was in excess of in-sediment criteria for Cr, Cu, Fe, Mn, Ni, As, Cr, Co, and Zn. These excesses clearly affected intolerant species in the cases of Fe and Mn and therefore species diversity in Lake Hope. Although less clear, it is presumed that the excesses of the other metals also affect species diversity.

Problem Statement

Sandy Run is in non-attainment of its WWH designated use because of low pH and metals associated with AMD. Lake Hope is in partial attainment of its EWH designated use because of low pH and metals.

Limited and contradictory data is available to accurately assess acid or alkaline loads to Raccoon Creek from Sandy Run and the relative impact on Raccoon Creek.

Goals

1. Determine chemical and biological condition of Sandy Run upstream of Lake Hope.
2. Determine if Sandy Run is an acid loading tributary to Raccoon Creek.
3. Improve chemical and biological quality of Lake Hope because it is a recreational asset to the Raccoon Creek watershed.

Action Plan

Actions in Sandy Run are to collect additional data to assess if any remediation actions are necessary in Sandy Run to: improve Lake Hope, improve Sandy Run upstream Lake Hope, or to reduce any acid load from Sandy Run to Raccoon Creek. The 2002 Raccoon Creek Headwaters AMDAT recommended additional treatment in Sandy Run via open limestone channels to create more buffering capacity before entering Lake Hope. The cost estimate for this treatment was estimated at $126,092. Both costs and treatment alternatives need to be reevaluated before implementation.

Table 24. Action Table for Sandy Run 14-digit HUC Watershed

Objective	Action	Resources	Time Frame	Performance Indicators
Monitor water quality in Sandy Run	Chemical data collection at MSLH121 and MSLH122 twice yearly	Staff and volunteers for data collection, ODNR-DMRM sample analysis	2008 - 2010	Water quality data entered into online database, annual report
Assess biological condition in Sandy Run	Biological data collection at MSLH121	Ohio EPA or ODNR-DMRM or ODNR-DOW assistance	2009	Biological data entered into online database, 2010 progress report; use attainment determination
AMD treatment in Sandy Run	Alkaline addition in Big Four Hollow or in Sandy Run (MSLH122)	$126,092 from ODNR-DMRM abandoned mine land program, Ohio EPA 319 program, others.	2009 - 2012	Conceptual treatment design completed, engineering design completed, treatment installed

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Appendix 1: Local Endorsement of Raccoon Creek Headwaters To Above Hewett Fork Watershed Action Plan

Raccoon Creek Partnership

Chairperson, Board of Supervisors: Jen Bowman

Signature: Jennifer Bowman

Date: 8-5-08

Vinton Soil and Water Conservation District

Board Supervisor: Bill Nose

Signature: Wm. A. Nose

Date: 6-18-08

Hocking Soil and Water Conservation District

Board Supervisor: Richard Harwood

Signature: Richard A Harwood

Date: 8-5-08

Appendix 2. Raccoon Creek Watershed Contributing Organizations and Agencies

Organization/Agency	Role / Responsibility
Vinton SWCD	- Water quality project implementation - Outreach and education - Technical advisor - Water quality data collection and analysis - Program and project development
ODNR Division of Mineral Resource Management	- Project development, design, oversight, implementation, and analysis - Water quality sample analysis - Technical advice and expertise - Funding towards water quality projects and research - AMDAT development
Ohio University's Voinovich School of Leadership & Public Affairs	- Coordination and fiscal sponsor - Technical support including GIS, meeting space, planning, website, database management, and technical advice. - Graduate student assistantship(s)
ODNR Division of Soil and Water Conservation	- Education and outreach assistance - Technical advisor - Project planning and development - Networking with County SWCD's in watershed
Ohio State University Extension – South Centers	- AMD project implementation - Technical advisor - Education / Outreach - Project development and planning
Gallia SWCD	- Education and outreach activities - Program planning and fundraising - Technical assistance
Athens SWCD	- Education and outreach partner - Technical assistance
Ohio Valley Resource Conservation District	- Technical assistance - Outreach assistance - Program and group development - Water quality project implementation
Office of Surface Mining Reclamation and Enforcement (OSMRE)	- Funding for AMD project implementation - Technical assistance
Ohio University – Environmental Studies Program	- Graduate student assistantships - Outreach assistance
Ohio University – Geological Sciences	- Graduate student research - Data analysis and interpretation assistance - Project development
Ohio University – Biological Sciences	- Bio-monitoring program development assistance - Student assistance and collaboration - Biological data collection and analysis
Ohio University – Department of Geography	- Research and project assistance
Ohio University – Department of Civil Engineering	- Data analysis and interpretation - Data collection - AMD project assistance
ODNR Division of Wildlife	- Biological data collection and analysis - Water trail development - Funding for AMD projects and right of entry for AMD projects on property
ODNR – Division of Forestry: Zaleski State Forest	- Partnership for annual litter clean up - Partner in AMD reclamation, water trail development, and research
Sojourners Care Network – Ohio Outback Conservation Corps	- Watershed activities assistance (outreach) - AMD project development and implementation
Raccoon Creek Water Trail Association	- Public outreach and education - Watershed promotion
Ohio EPA – Southeast District	- Water quality and biological data collection, assistance, and support

	- Project development and planning - Technical assistance
Moonville Rail Trail Association	- Outreach partner - Partnership for water and rail trail development
Midwest Biodiversity Institute	- Biological data collection and analysis - Technical assistance and bio-monitoring program development
USFS - Wayne National Forest	- AMD project landowner - AMD project implementation partner - Technical advising and support

Appendix 3. Bylaws of the Raccoon Creek Partnership

ARTICLE I. - NAME

The name of the organization shall be the ***Raccoon Creek Partnership*** and referred to as the ***RCP***.

ARTICLE II. – PURPOSE

The mission of the Raccoon Creek Partnership is "to work toward conservation, stewardship, and restoration of the watershed for a healthier stream and community".

The primary objectives of the Raccoon Creek Partnership are:

1. To partner with local, state and federal agencies and organizations to facilitate and implement water quality restoration, enhancement, and protection projects.
2. To conduct outreach activities and provide environmental education to the public and watershed partners with regard to Raccoon Creek watershed management.
3. To create, enhance, and promote recreational opportunities on Raccoon Creek.
4. To support and coordinate watershed related research activities.
5. To develop and support stewardship programs to activate and educate the local watershed community.
6. To advocate and support activities that support and further the mission of the RCP.

ARTICLE III. - NATURE

This organization is formed as a partnership of individuals, businesses, agencies, organizations, institutions, corporations, and governmental units with the common mission and purpose of the Raccoon Creek Partnership.

Said organization is organized exclusively for charitable, religious, educational, and scientific purposes, including, for such purposes, the making of distributions to organizations that qualify as exempt organizations under section 501 (c) (3) of the Internal Revenue Code, or corresponding section of any future federal tax code.

Notwithstanding any other provision of this document, the organization shall not carry on any other activities not permitted to be carried on (a) by an organization exempt from federal income tax under section 501 (c) (3) of the Internal Revenue Code, or corresponding section of any future federal tax code, or (b) by an organization, contributions to which are deductible under section 170 (c) (2) of

the Internal Revenue Code, or corresponding section of any future federal tax code.

ARTICLE IV. – MEMBERSHIP

The corporation shall have two levels of membership, designated as "General" and "Supporting".

1. ***General Membership***: General membership may be extended to any agency, business, organization, corporation, governmental unit, or other entity that is interested in promoting the common mission and purpose of the Raccoon Creek Partnership. Members are considered in good standing at the first of the month in the month that annual dues are paid.

    a) General Membership in the Raccoon Creek Partnership will commence with the signing of a membership agreement and membership will be effective the date of receipt of payment of dues.
    b) Each General Member is entitled to one vote. Organizations, agencies (or divisions of), businesses, corporations, governmental units, and other entities shall designate a voting representative and an alternate.
    c) Each General Member shall have the privilege to nominate and elect board members, vote on bylaw amendments, articles of incorporation, dues, and other issues brought forth by the Board of Directors.
    d) Each General Member may bring forth issues related to the mission, purpose, function, and funding to the Board of Directors of the Raccoon Creek Partnership.
    e) General Membership may be revoked for just cause as determined by a two-thirds majority vote on the Board of Directors and a simple majority vote of the members present at the next scheduled meeting.

2. ***Supporting Membership***: Supporting membership may be extended to any individual interested in promoting the common mission and purpose of Raccoon Creek Partnership. This provision is to allow and encourage participation from individuals who desire to support the Raccoon Creek Partnership but who do not represent any entity or organization.

    a) Supporting Membership in the Raccoon Creek Partnership will commence with the issuance of a membership card by the Treasurer, effective the date of payment of dues.
    b) Each Supporting Member has the privilege to nominate and vote for the Board of Directors at the annual meeting.
    c) Supporting Members may bring forth issues related to the mission, purpose, function, and funding to the Board of Directors of the Raccoon Creek Partnership.

d) Membership may be revoked for just cause as determined by a two-thirds (2/3) majority vote on the Board of Directors and a simple majority vote of the members present at the next scheduled meeting.

ARTICLE V. – DUES

Dues shall be reviewed and recommended annually by the Board of Directors and approved by a simple majority vote of the members present at a regularly scheduled meeting. Dues shall be renewed annually and payment will be due in full the first of the month in which dues were collected the previous year. New members shall be required to make payment in full with a signed partnership agreement.

ARTICLE VI. – MEETINGS

Meetings of the Raccoon Creek Partnership will consist of three types, "annual", "regular", and "special".

a) "***Annual Meetings***" – shall be held during the last quarter of the fiscal year.
b) "***Regular Meetings***" - shall be conducted quarterly with dates to be set at the annual meeting for the next year.
c) "***Special Meetings***" – may be scheduled by the Chairperson and/or the Board of Directors. The secretary shall send out notices of special meetings to each member marked two weeks in advance.

ARTICLE VII. – BOARD OF DIRECTORS

There shall be a Board of Directors of seven (7) elected members. All Board members will be elected by the entire membership present at the annual meeting, beginning with the first annual meeting. All Board members are required to be a member of the Raccoon Creek Partnership and in "good standing".

An interim board will be established for the organization until elections can be held at the first annual meeting of the organization.

The initial Board of Directors terms will be staggered to avoid complete turnover of the Board. Four of the initial Board members terms will be two years in length and three of the board members terms will be one year in length. Board members elected beginning with the second election and beyond will serve a two-year term. A Board of Director's term will begin with annual meeting in which elected and end at the close of the annual meeting, which their term expires. Board members may serve a maximum of three consecutive terms.

A quorum shall be required to conduct business at all board meetings. A quorum is defined as 51% of the Board of Directors. If the meeting has been advertised

and scheduled in advance to the membership, the membership present shall constitute a quorum. A majority vote of the Board of Directors present shall be required to pass a motion.

When a vacancy on the Board exists, nominations for new members may be received by the Secretary or Chairperson from present Board members two weeks in advance of a Board meeting. These nominations shall be sent out to Board members with the regular Board meeting announcement, to be voted upon at the next Board meeting. A Board vacancy will be filled through nomination from the Board only to the end of the vacant Board members term when a new election will occur.

Resignation by a Board member must be in writing and received by the Secretary. A board member can be dismissed from the Board for excessive absences if he/she has three unexcused absences from Board meetings in a year. A Board member may be removed for other reasons by a two-thirds (2/3) majority vote on the Board of Directors and a simple majority vote of the members present at the next regularly scheduled Raccoon Creek Partnership meeting.

ARTICLE VIII. – OFFICERS AND DUTIES

Officers of the RCP shall serve one (1) year terms with reappointment optional each year. These officers shall be nominated and elected by a majority vote of the Board of Directors at the first Board meeting following the annual meeting. In the case of death, resignation, or inability to continue as an officer, the Board of Directors may declare the office vacant and appoint his/her successor. All officers shall be nominated and elected from the currently serving Board of Directors.

Chairperson – Duties of the chairperson shall be to determine the regular meeting schedule, preside over all meetings of the RCP, call special meetings of the RCP and Board of Directors, determine agendas for the meetings, appoint committees, perform all acts and duties usually performed by an executive or presiding officer, and sign all membership agreements and other such papers of the RCP as authorized by the Board of Directors on their behalf.

Vice-Chairperson – Duties of the vice-chairperson shall include all duties of the chairperson in his/her absence.

Treasurer – The treasurer shall have general charge and supervision of the RCP's financial records including handling all receipts and disbursements of all monies. He/she shall serve, mail, or deliver all notices required by law and these bylaws. He/she shall make a full report of all matters and business pertaining to the office to the members at the Annual Meeting or at such other times as the president directs. He/she shall make all reports

as required by law and perform other duties required by the RCP. Upon election of a successor, the treasurer shall turn over all books and other property belonging to the RCP that he/she may have in his/her possession. The treasurer shall cooperate with the president in an audit of the financial records.

Secretary – The secretary shall keep a complete record of all meetings of the RCP and make the minutes available to the membership. He/she shall make all reports as required by law and perform other such duties as required by the RCP.

ARTICLE IX. – COMMITTEES

1. **Standing Committees** – Standing Committees will operate as an entity of the board of directors and will work towards achieving specific duties of the Board and toward the RCP's mission and goals. Standing Committee Chairperson(s) will be appointed by the Board of Directors and will be responsible for conducting committee meetings and reporting to the Board about committee activities and recommendations. Standing Committee membership is open to any member of the RCP.

a) Finance Committee - The "Treasurer" will serve as the chair of the Finance Committee, which will include at least three (3) other board members. Additional RCP members may serve on the finance committee if interested. The Finance Committee is responsible for developing and reviewing fiscal procedures, a fundraising plan, and an annual budget with staff and other board members. The Board must approve the budget, and all expenditures must be within the budget. The Board must approve any major changes to the budget. The committee shall prepare a report attesting to the financial condition of the RCP as of January 1st each year for the preceding year and submit the report to the Chairperson of the RCP prior to the annual meeting for attachment to the Annual Treasurer's Report. The financial records of the organization are public information and shall be made available to the membership, Board members, and the public.

b) Technical Advisory Committee – The Technical Advisory Committee, i.e. Raccoon Creek Forum, will assist with and develop research ideas, and investigate, plan, and recommend water quality improvement or protection projects for the RCP. The committee will provide advice, direction, and guidance on scientific and technical matters related to water quality and watershed issues to the Board and members.

c) Membership and Development Committee – The Membership and Development Committee will evaluate and provide guidance to the Board and members regarding operating procedures and policy. The

committee will also be responsible for recruiting partnership members and handle membership related tasks.

2. **Special Committees** – The Board of Directors shall have the authority to appoint special committees as necessary, and at their discretion, and to appoint a chairperson of that committee from the Board. Special Committee membership is open to any member of the RCP.

ARTICLE X. – FINANCIAL PROVISIONS

The fiscal year of the organization shall begin the 1st day of January in each calendar year.

Disbursements shall be made by check, with two signatures. A check can be signed by the Treasurer, Chairperson and any other alternate person authorized by the Board. Disbursements in conformance with an approved budget of less than $500 may be made without the Board approval. Disbursements not in conformance with an approved budget or over $500 will first need to be approved by the Board.

ARTICLE XI. – QUORUM

A quorum shall be required to conduct Raccoon Creek Partnership business at partnership meetings. A quorum is defined as 51% of the Raccoon Creek Partnership General Membership. If the meeting has been advertised and scheduled in advance to the membership, the membership present at the meeting shall constitute a quorum. A majority vote of the General Membership present shall be required to pass a motion.

ARTICLE XII. - AMENDMENT PROCEDURES

Proposed amendments to the Bylaws shall be presented in writing to each member of the Board of Directors at least thirty (30) days prior to the Board of Director's meeting at which the amendment is proposed to be adopted. An affirmative vote of two-thirds (2/3) of the Board of Directors shall be necessary for adoption of amendments to the Bylaws. When the Board of Directors has approved amendments to the Bylaws, they shall be submitted to the membership of RCP for a simple majority approval at the next meeting.

ARTICLE XIII. - INDEMNIFICATION

The RCP shall indemnify every Director and officer, his/her heirs, executors, and administrators against all loss, cost, and expense reasonably incurred by him/her in connection with any action, suit, or proceeding to which s/he may be made a party, by reason of his/her being or having been a member of the Board or officer of the organization, including reasonable matters wherein s/he shall be finally

adjudged in such liability, damage, or injury is covered by any type of insurance; however, this indemnification shall not cover any acts of gross negligence, willful misconduct, or with fraudulent or criminal intent. The foregoing rights shall be in addition to and not exclusive of all other rights to which such Director/Officer may be entitled.

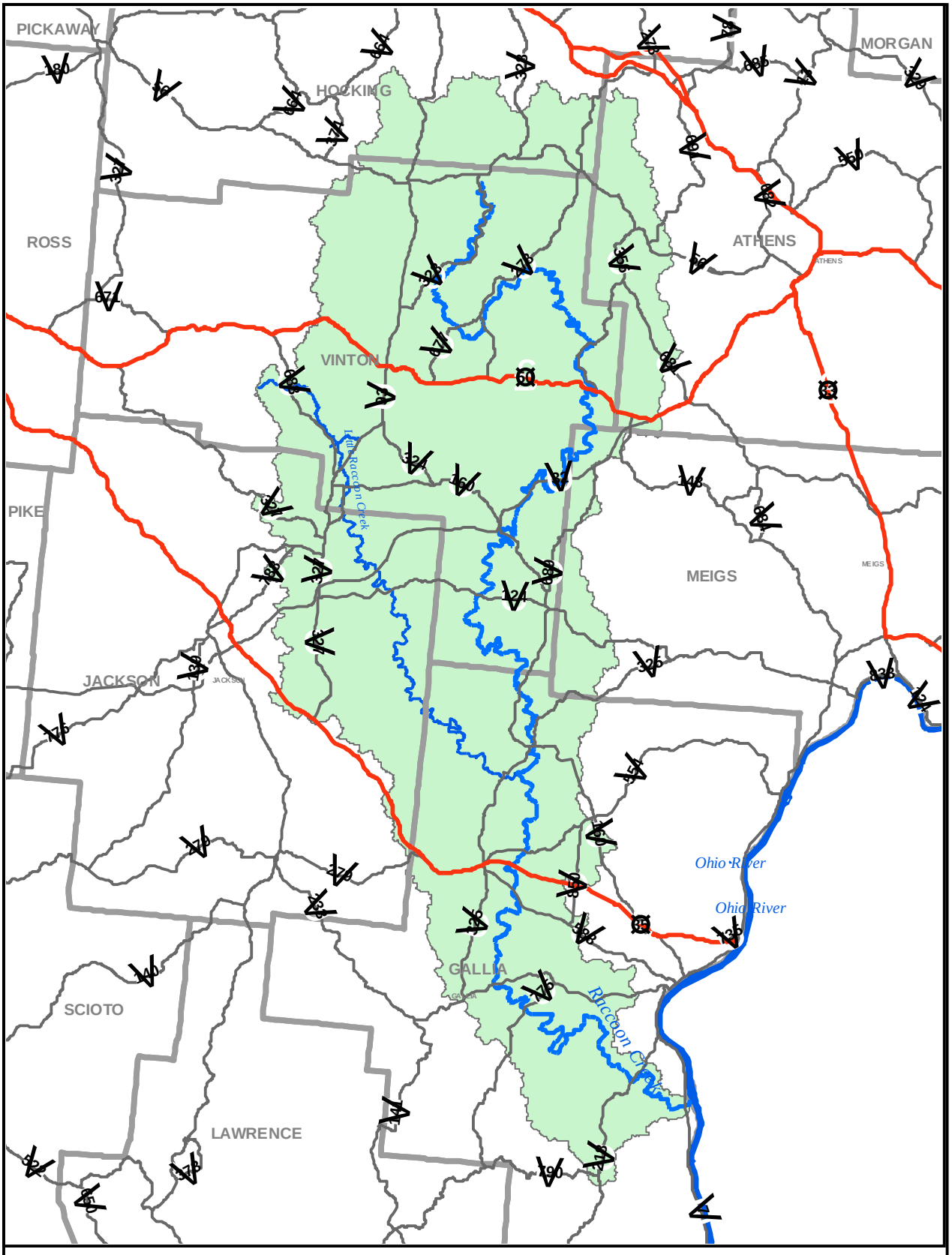
ARTICLE XIV. - DISSOLUTION

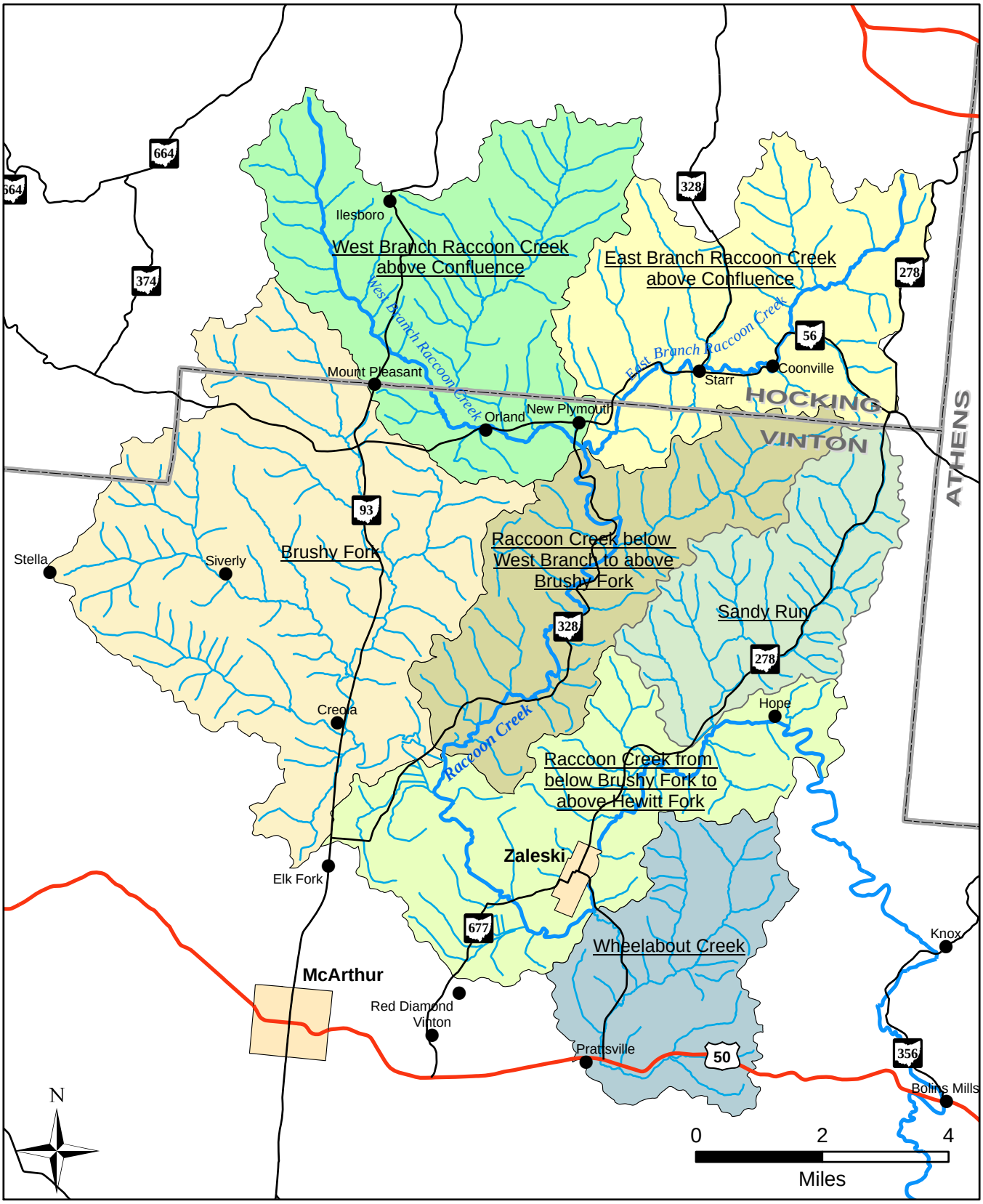
Upon the dissolution of the organization, assets shall be distributed for one or more exempt purposes within the meaning of section 501 (c) (3) of the Internal Revenue Code, or corresponding section of any future federal tax code, or shall be distributed to the federal government, or to a state or local government, for a public purpose. Any such assets not disposed of shall be disposed of by the Court of Common Pleas of the county in which the principal office of the organization is then located, exclusively for such purposes or to such organization or organizations, as said Court shall determine, which are organized and operated exclusively for such purposes.

We certify that the forgone bylaws were duly adopted by the members on _____, that the same are in full force and effective and have not been amended. Given under our hands and the seal of the corporation, this _____ day of _____, 20____.

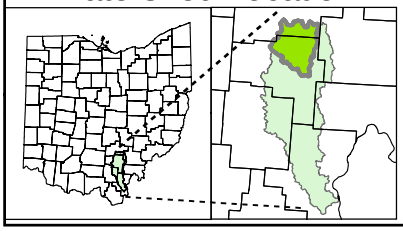
Chairperson, _____

Secretary, _____


PICKAWAY
HOCKING
MORGAN
ROSS
ATHENS
VINTON
PIKE
MEIGS
JACKSON
GALLIA
SCIOTO
LAWRENCE
Little Raccoon Creek
Ohio River
Ohio River
Raccoon Creek
Legend
US Roads
State Roads
Raccoon Creek
OhioRiver
Counties
Little Raccoon Creek
Raccoon Creek Watershed
Map : 1
Raccoon Creek Watershed
0
4.5
9
18
Miles



Watershed Location

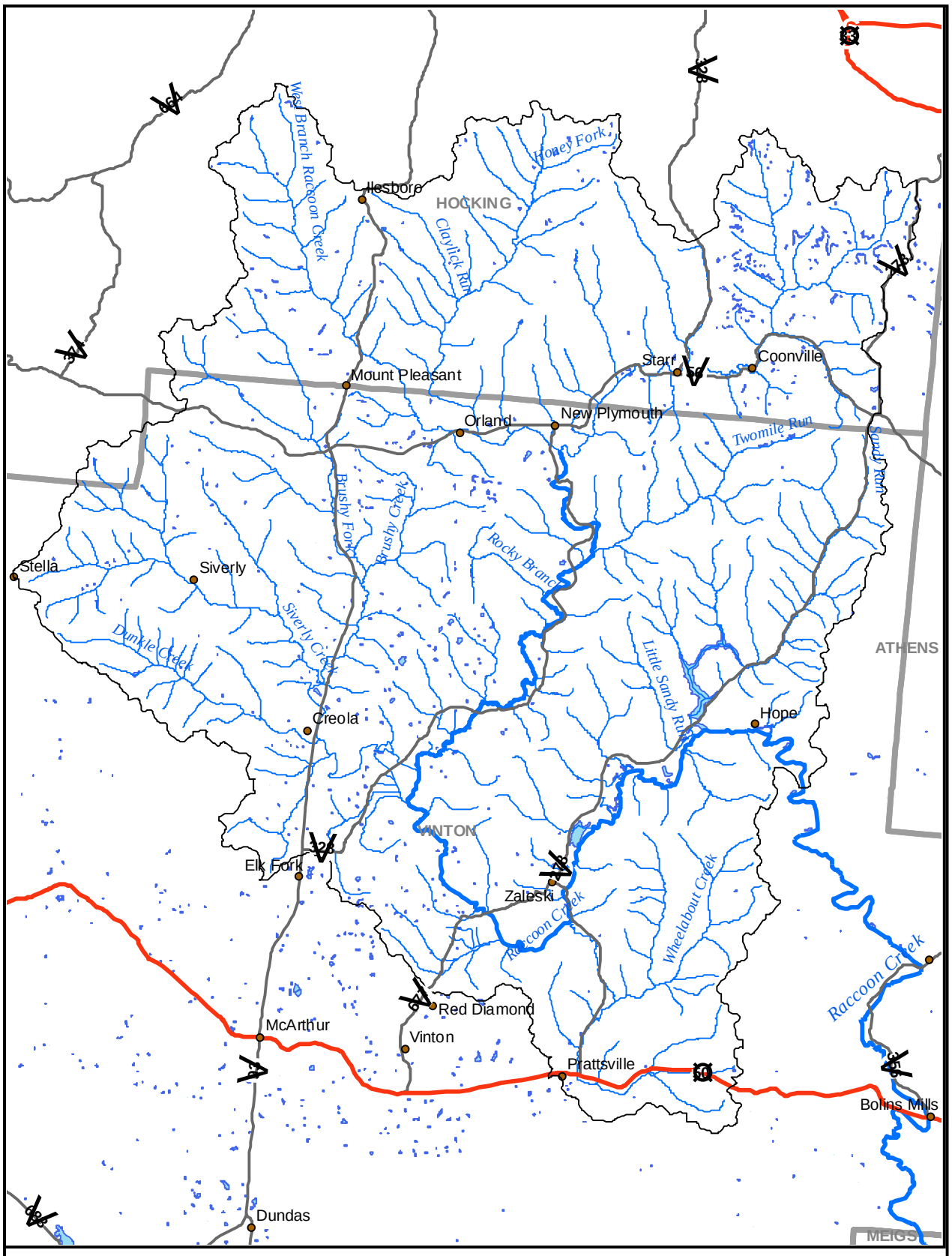


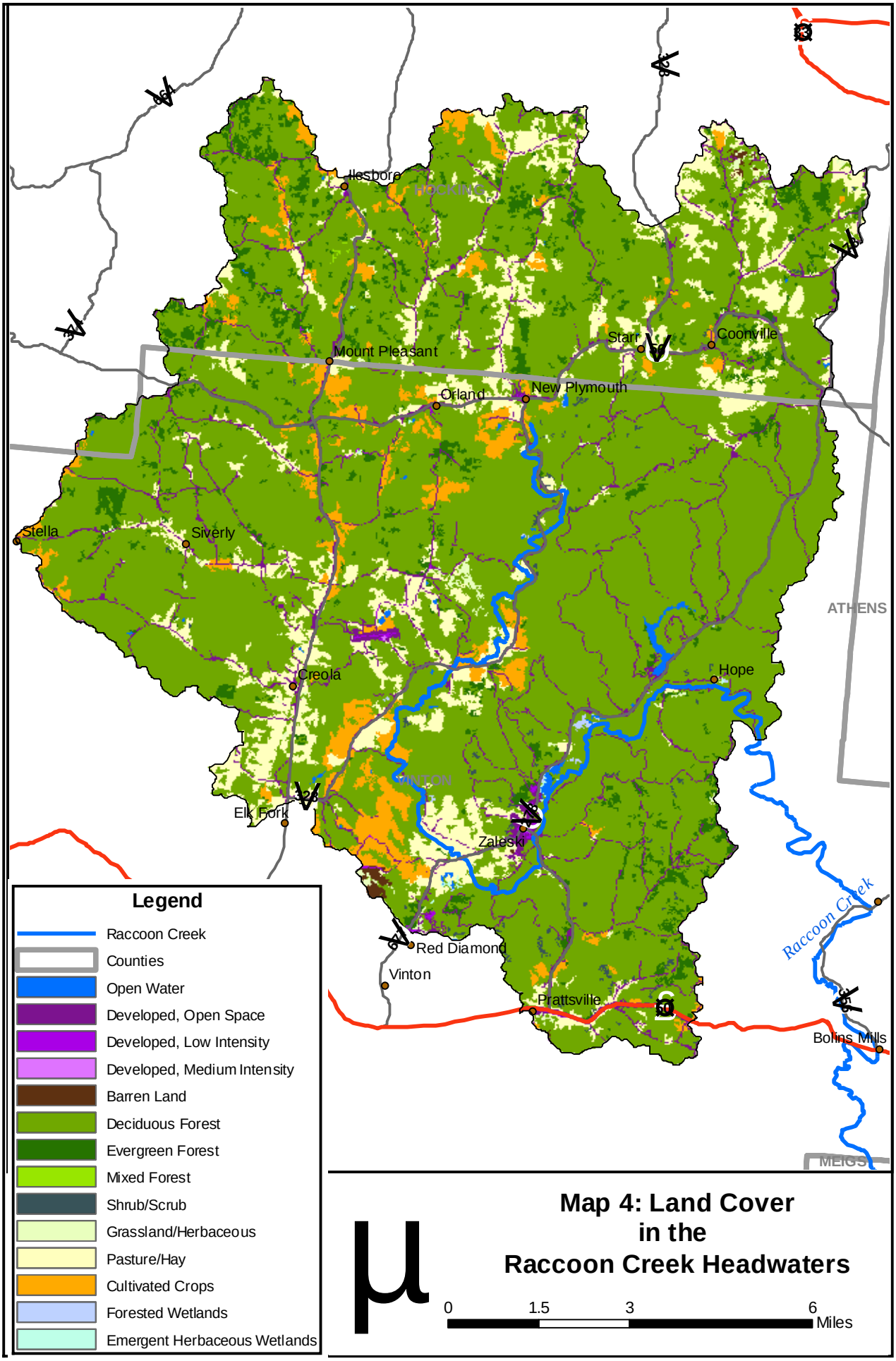
HUC 14-digit Subsheds

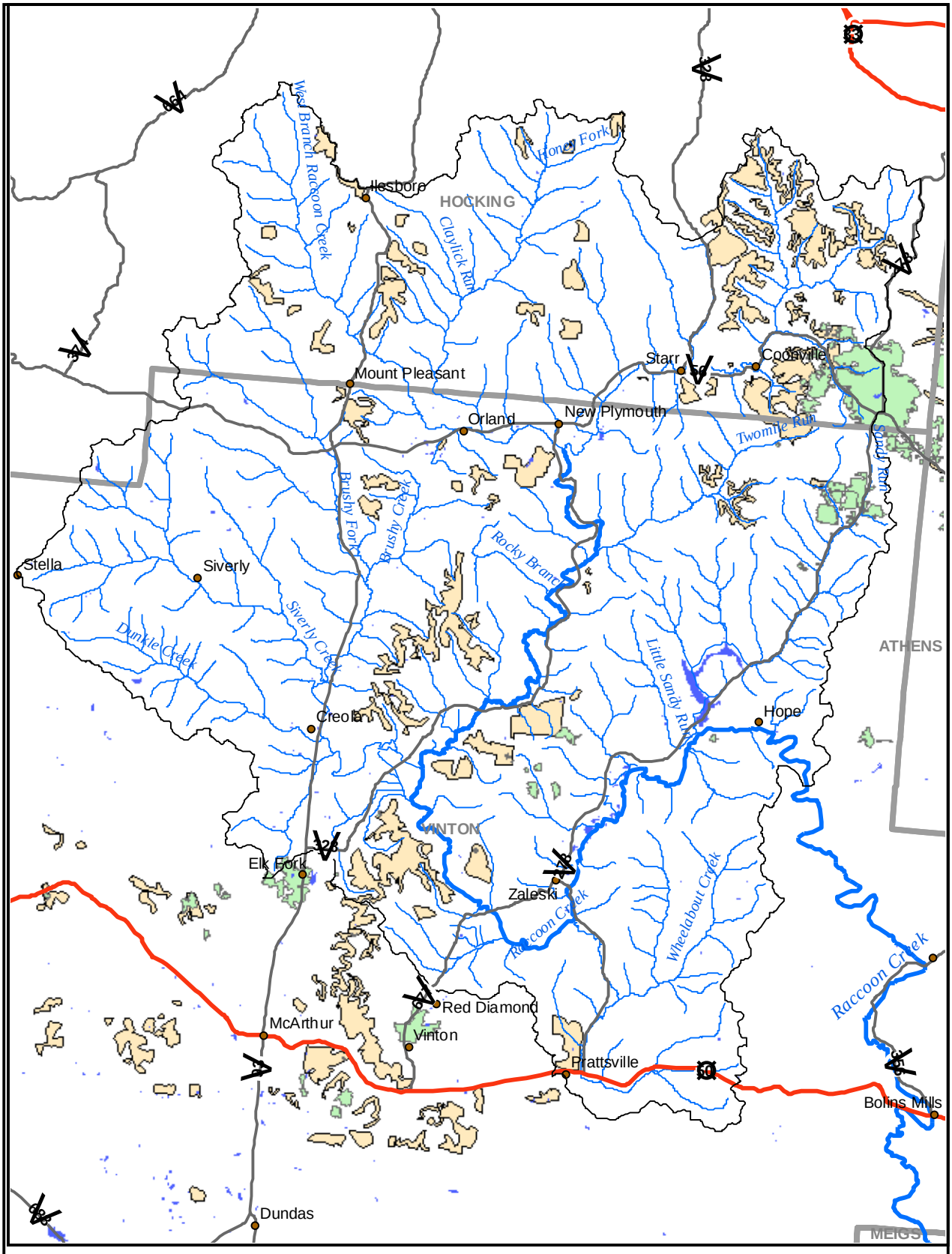
- 05090101020010
- 05090101020020
- 05090101020030
- 05090101020040
- 05090101020050
- 05090101020060
- 05090101020070

Map 2 - Raccoon Creek Headwaters to Above Hewett Fork

11 DIGIT HUC - 05090101020


West Branch Raccoon Creek
Honey Fork
Claylick Run
Ilesboro
HOCKING
Mount Pleasant
Orland
New Plymouth
Start
Coonville
Twomile Run
Sandy Run
Brushy Fork
Brushy Creek
Rocky Branch
Stella
Siverly
Siverly Creek
Dunkle Creek
Little Sandy Run
ATHENS
Creola
Hope
VINTON
Elk Fork
Zaleski
Raccoon Creek
Wheelabout Creek
Red Diamond
McArthur
Vinton
Prattsville
Bolins Mills
Dundas
MEIGS
Legend
Raccoon Creek
Counties
State Roads
US Roads
Towns & Villages
Streams
Lakes
Map : 3
Raccoon Creek
Headwaters Watershed
[HUC 05090101-020]
0
1.5
3
6
Miles


Ilesboro
HOCKING
Mount Pleasant
Orland
New Plymouth
Starr
Coonville
Stella
Siverly
ATHENS
Creola
Hope
VINTON
Elk Fork
Zaleski
Raccoon Creek
Red Diamond
Vinton
Prattsville
Bolins Mills
MEIGS
Legend
Raccoon Creek
Counties
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Cultivated Crops
Forested Wetlands
Emergent Herbaceous Wetlands
Map 4: Land Cover
in the
Raccoon Creek Headwaters
0
1.5
3
6
Miles



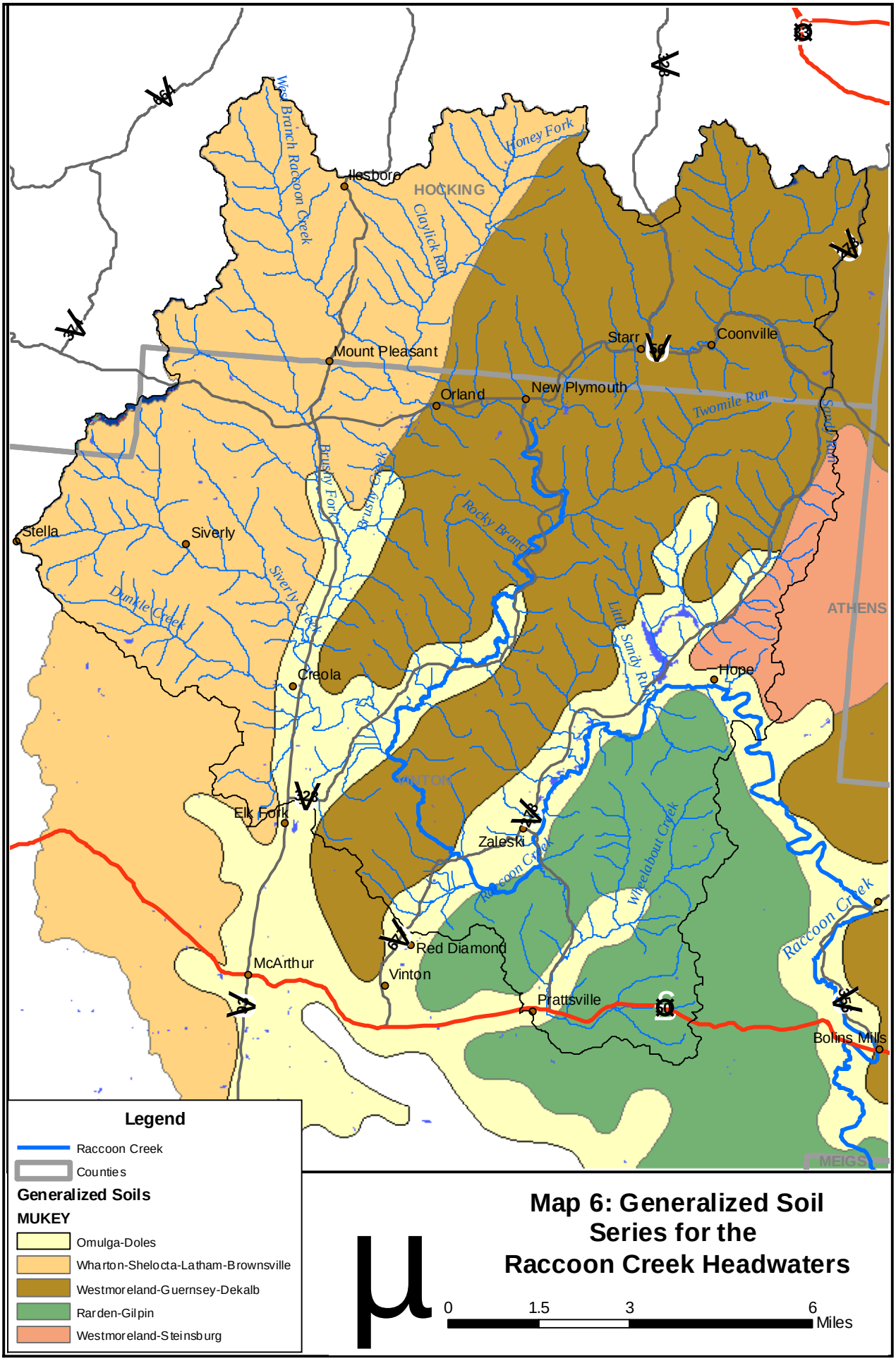
Legend

- Raccoon Creek
- Counties
- Underground Mines
- Surface Mines

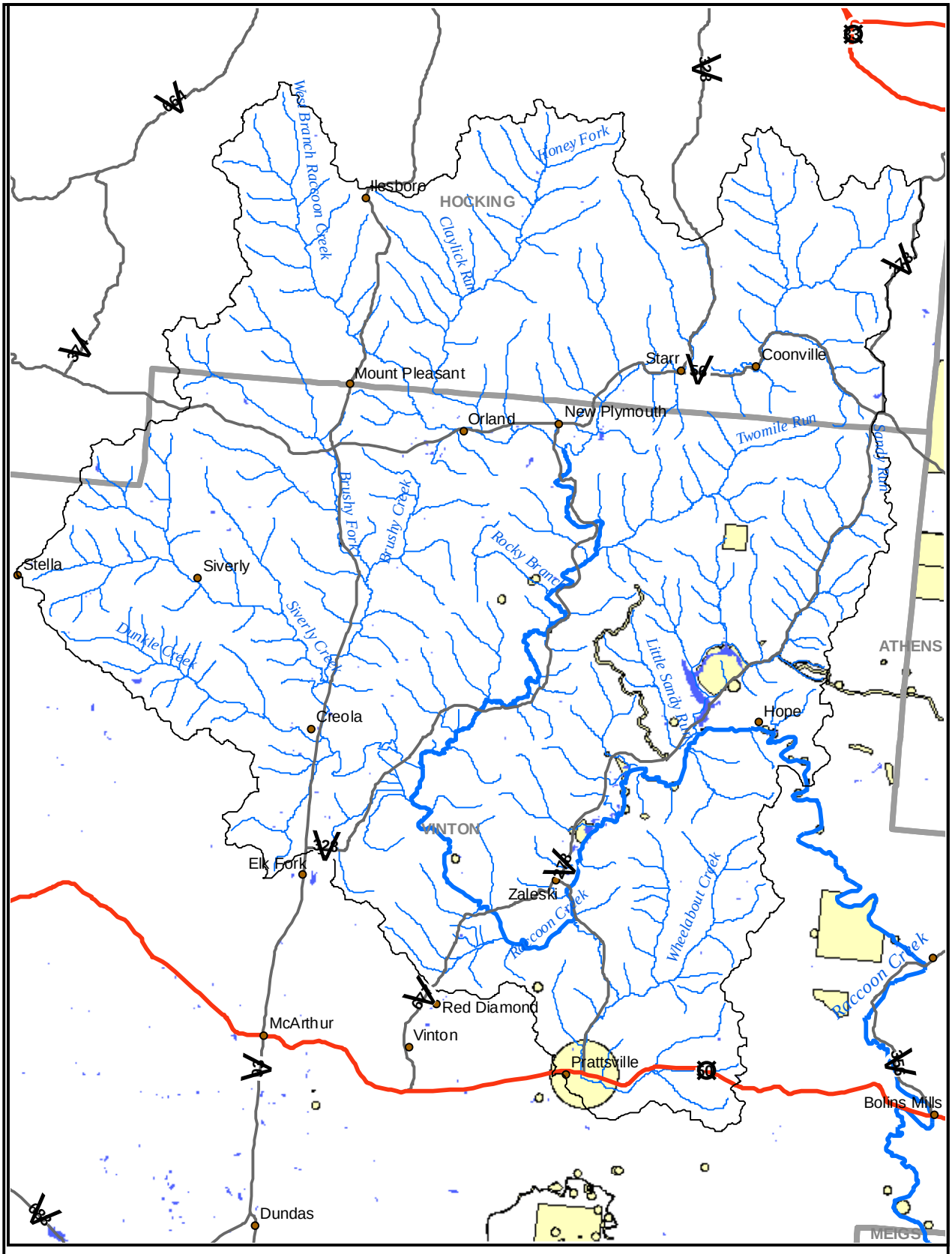
μ

Map 5: Mining Extent in the Raccoon Creek Headwaters

0 1.5 3 6 Miles



Map 6: Generalized Soil Series for the Raccoon Creek Headwaters



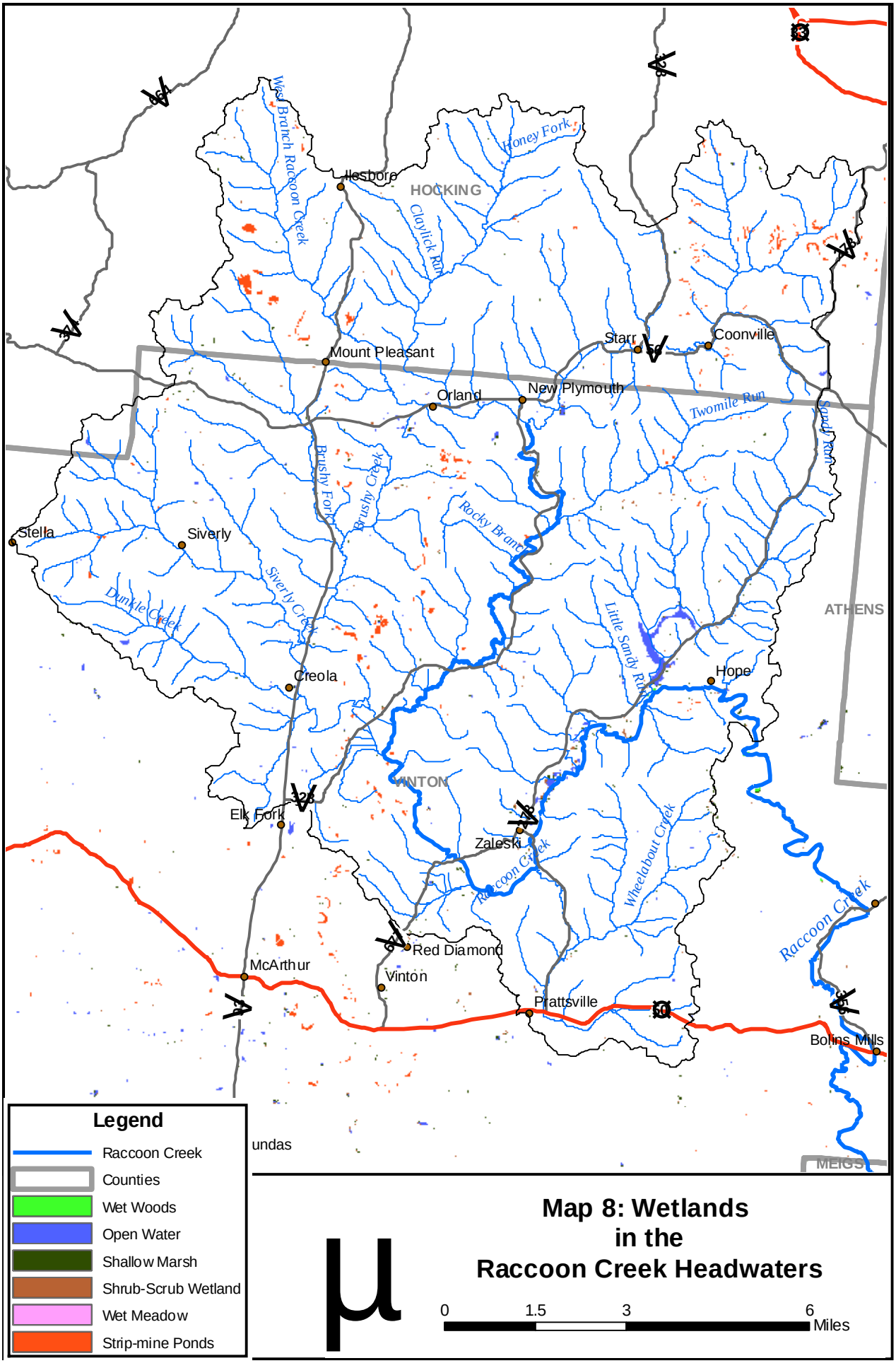
Legend

- Raccoon Creek
- Counties
- Rare & Unique Species

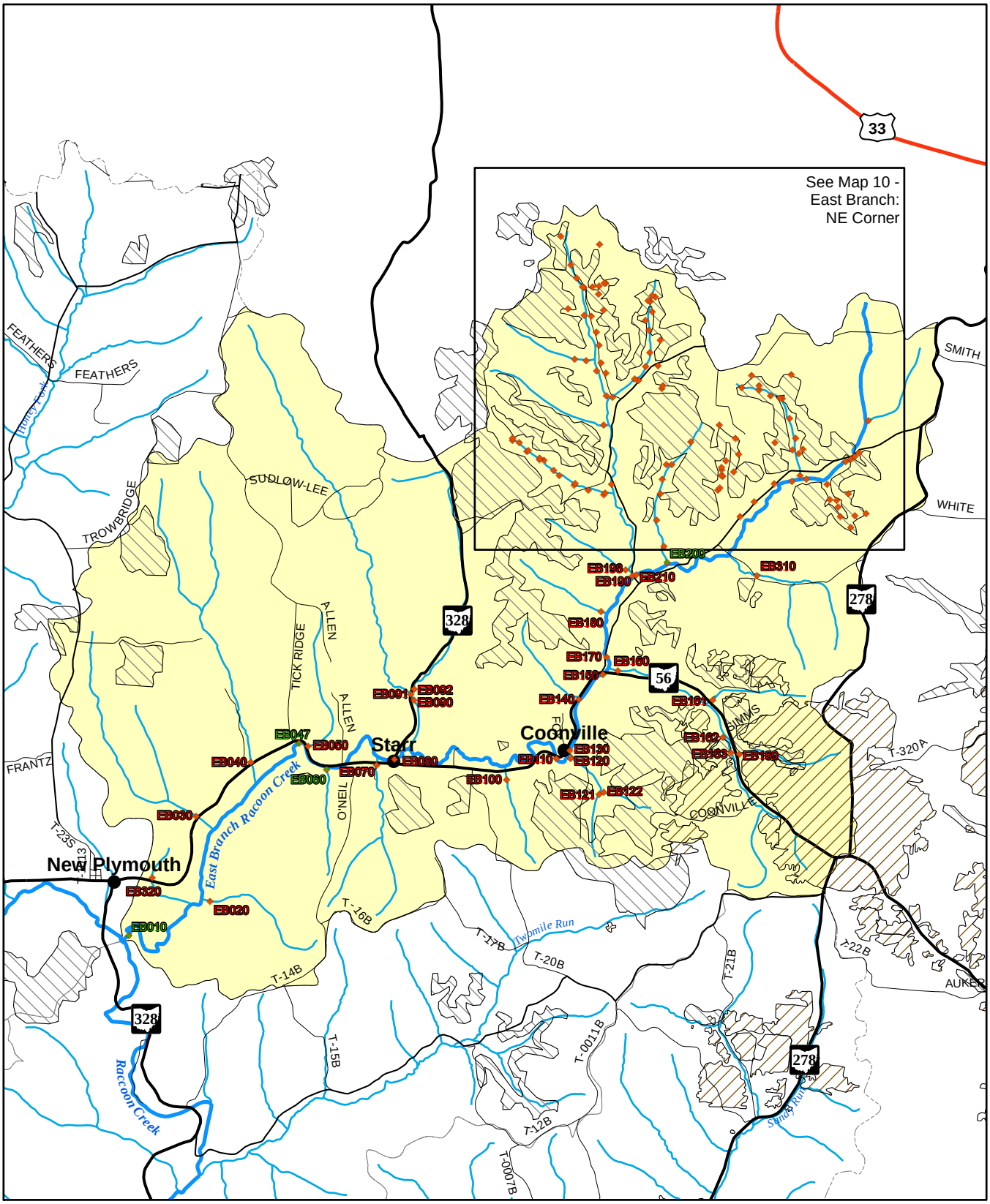
μ

Map 7: Rare and Unique Species Locations in the Raccoon Creek Headwaters

0 1.5 3 6 Miles



Map 8: Wetlands in the Raccoon Creek Headwaters



Raccoon Creek Headwaters

0 0.75 1.5

Miles

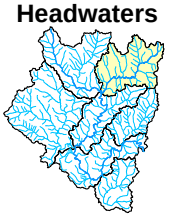
N

- Biological Sample
- Chemical Sample
- Surface Mine
- Underground Mine
- Streams
- County Rd
- Township Rd
- State Routes

Map 9 - East Branch Subwatershed

14 DIGIT HUC - 05090101020010

Raccoon Creek Headwaters



0 0.25 0.5

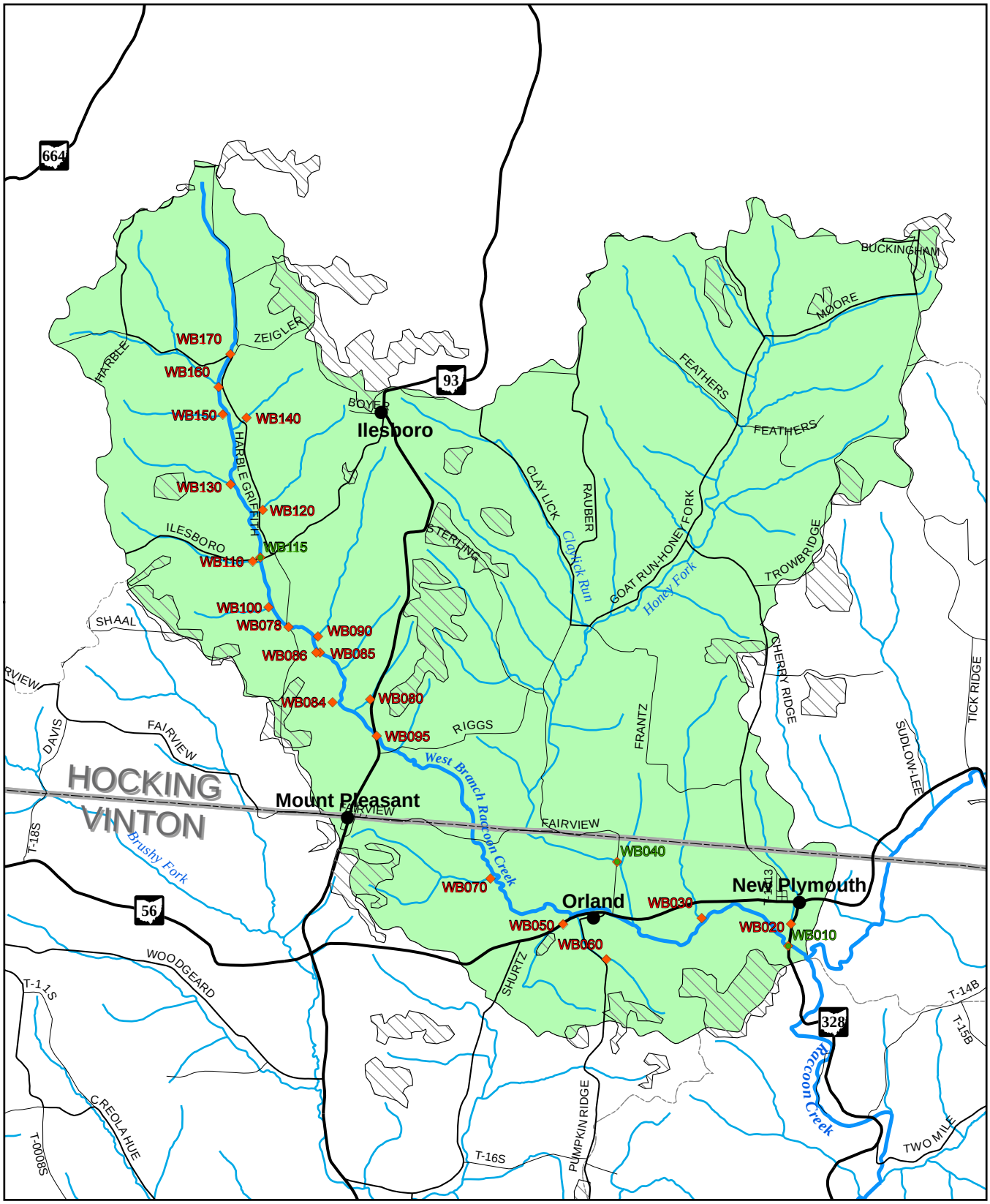
Miles

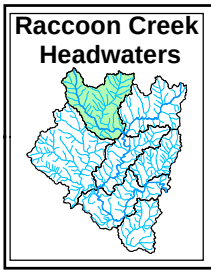
N

- Biological Sample
- Chemical Sample
- Surface Mine
- Underground Mine
- Streams
- County Rd
- Township Rd
- State Routes

Map 10 (Map 9 inset) - NE Corner East Branch

14 DIGIT HUC - 05090101020010





0 0.5 1

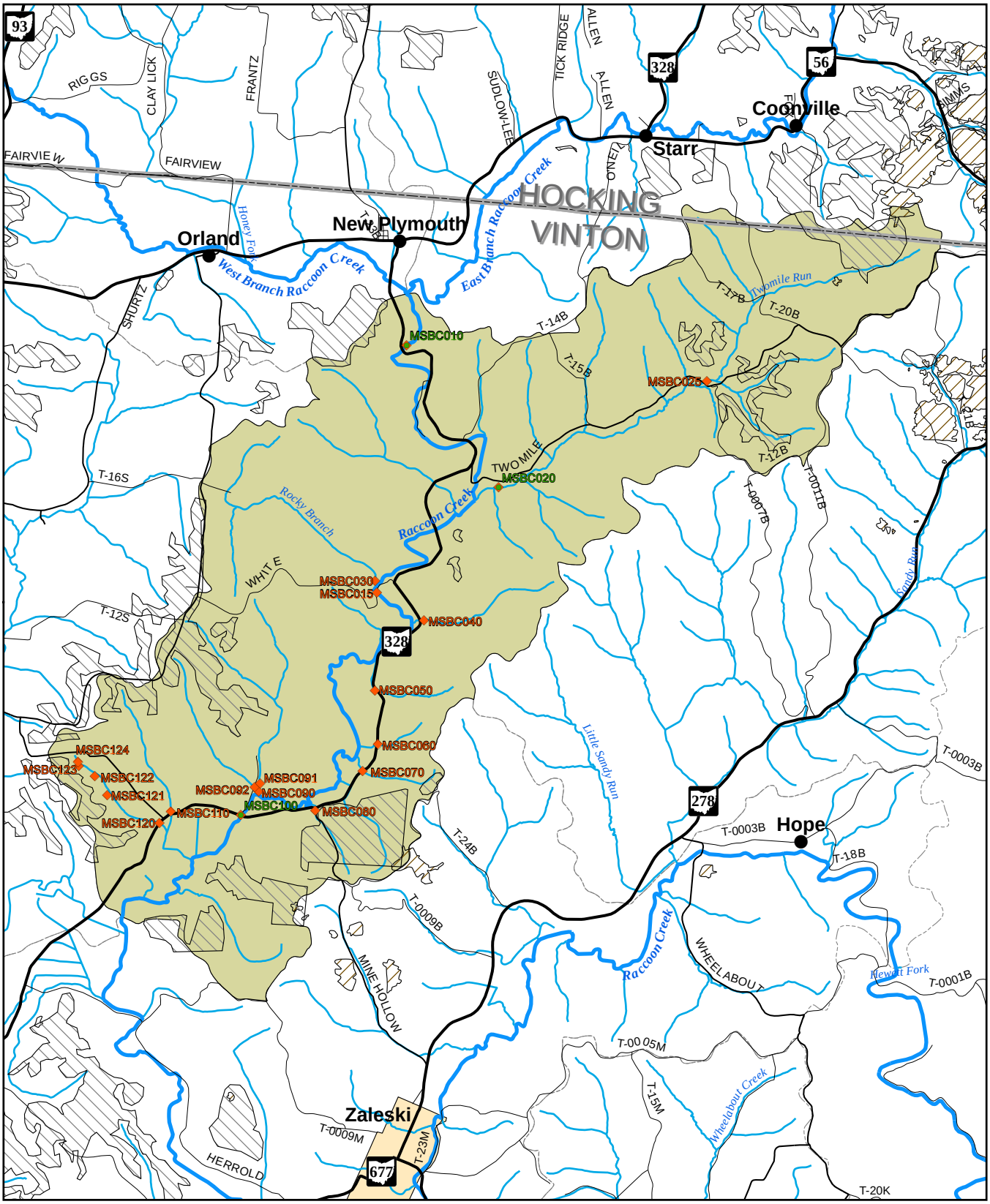
Miles

N

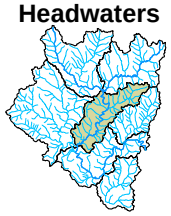
- Biological Sample
- Chemical Sample
- Surface Mine
- Underground Mine
- Streams
- County Rd
- Township Rd
- State Routes

Map 11 - West Branch Subwatershed

14 DIGIT HUC - 05090101020020



Raccoon Creek Headwaters



0 0.5 1 2

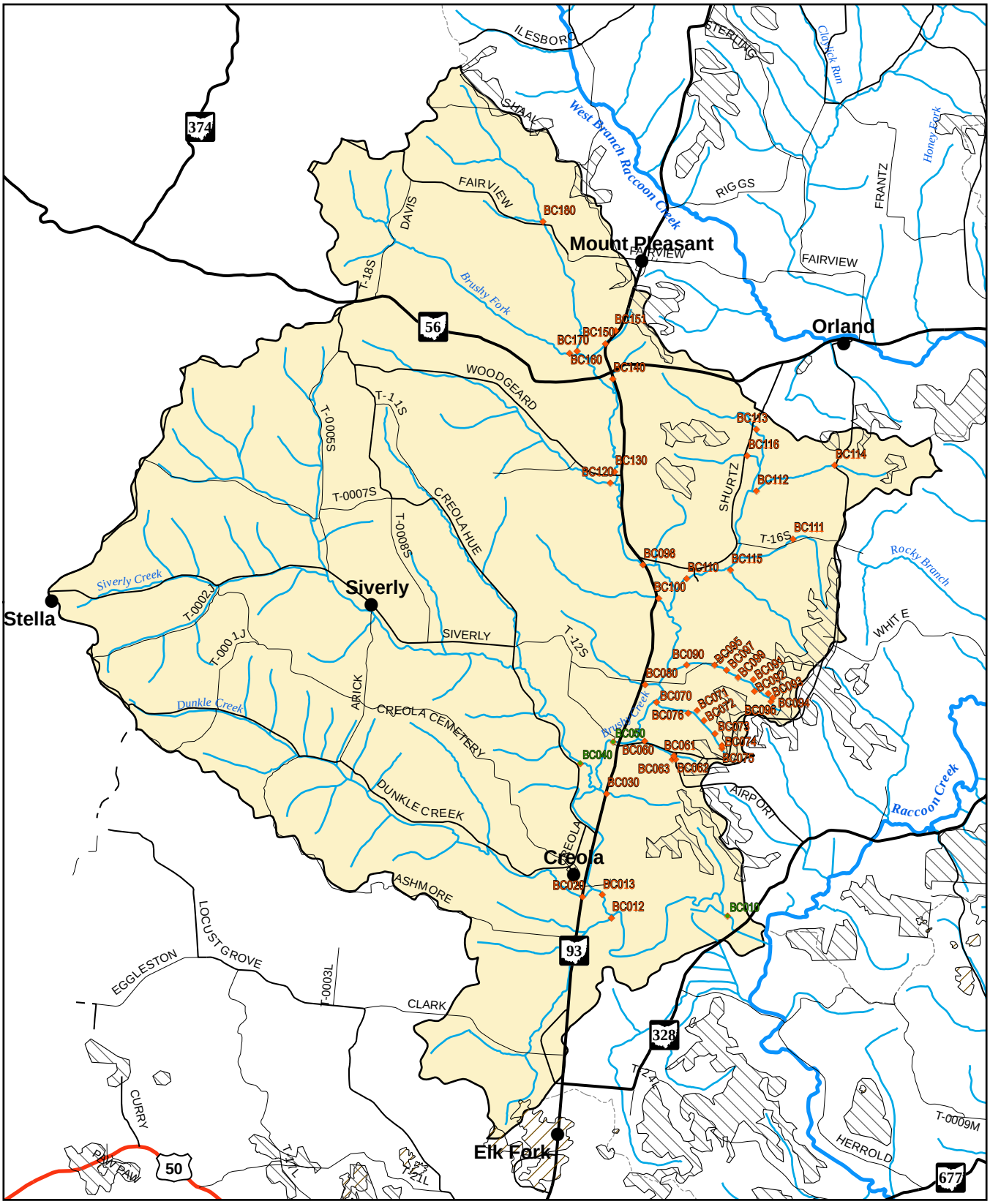
Miles

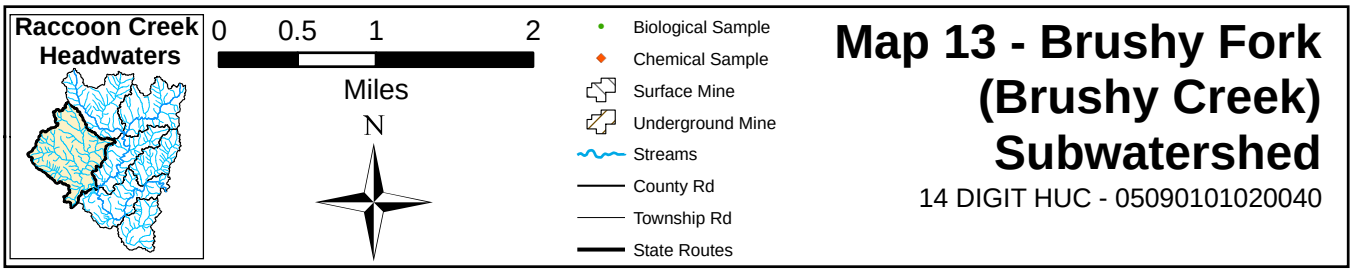
N

- Biological Sample
- Chemical Sample
- Surface Mine
- Underground Mine
- Streams
- County Rd
- Township Rd
- State Routes

Map 12 - Raccoon Creek - West Branch to Above Brushy Creek Subwatershed

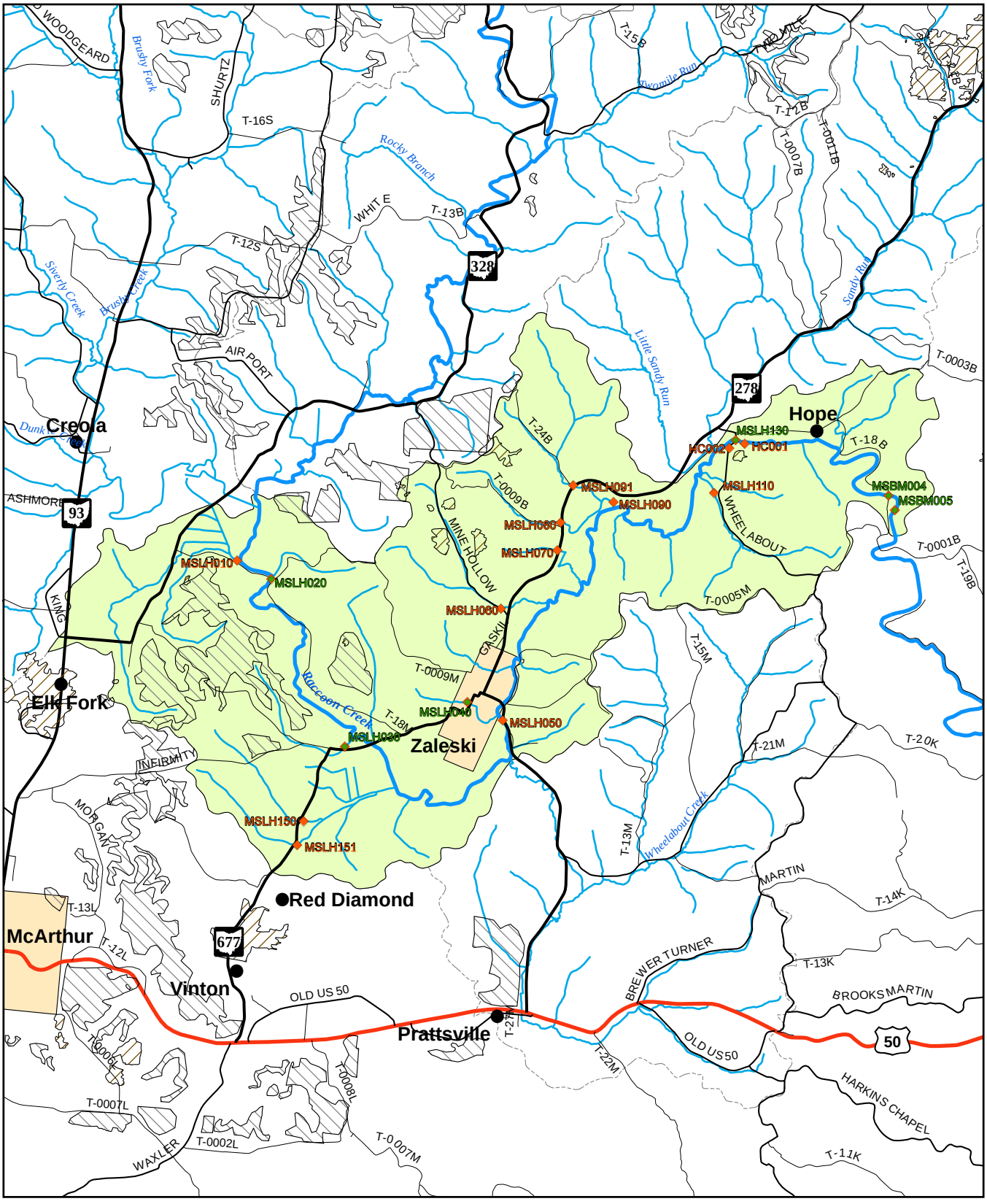
14 DIGIT HUC - 05090101020030





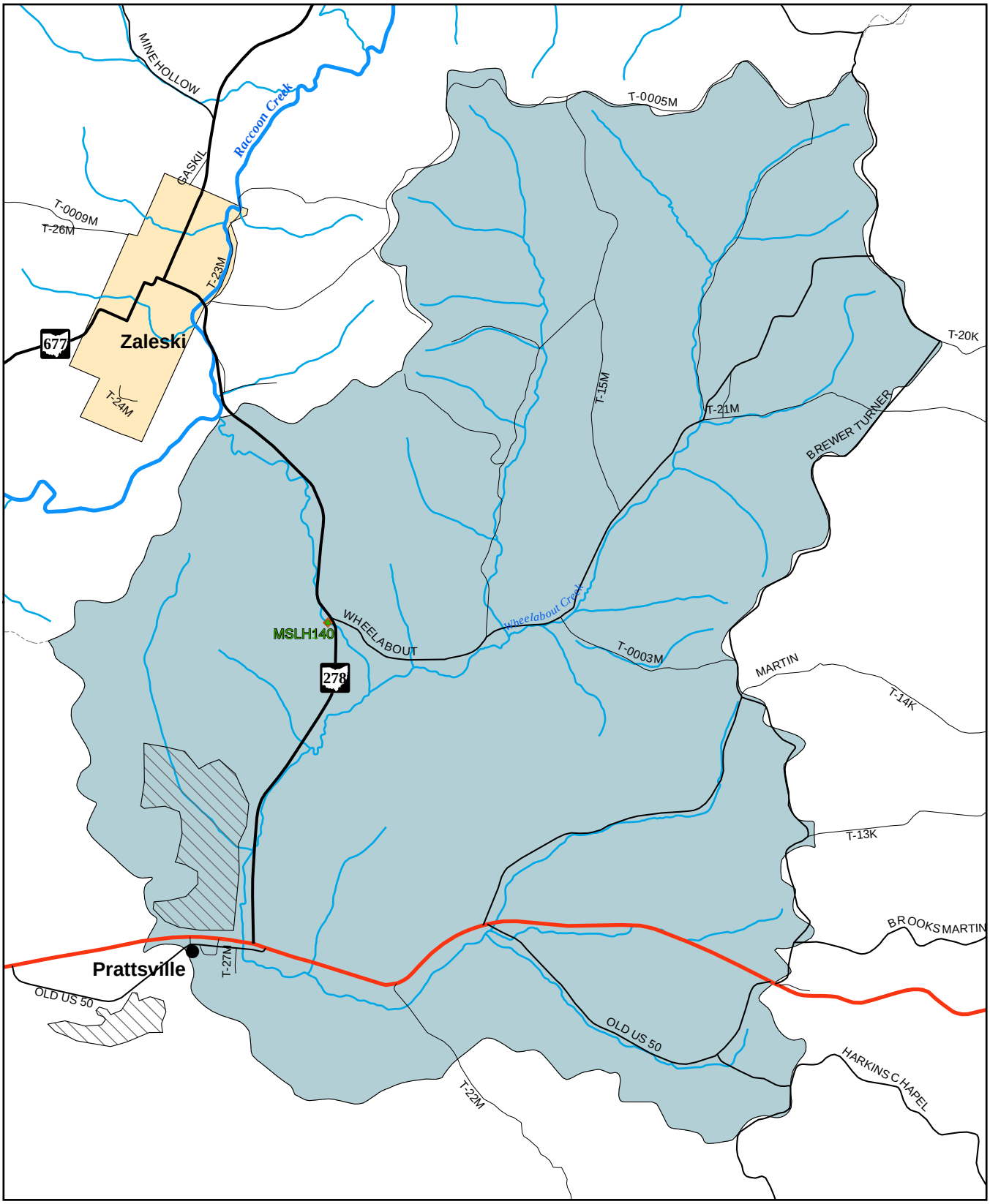
Map 13 - Brushy Fork (Brushy Creek) Subwatershed

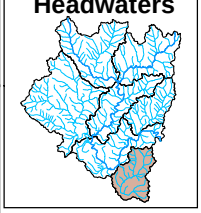
14 DIGIT HUC - 05090101020040



Map 14 - Raccoon Creek Below Brushy Fork to Above Hewett Fork Subwatershed

14 DIGIT HUC - 05090101020060





0 0.25 0.5 1

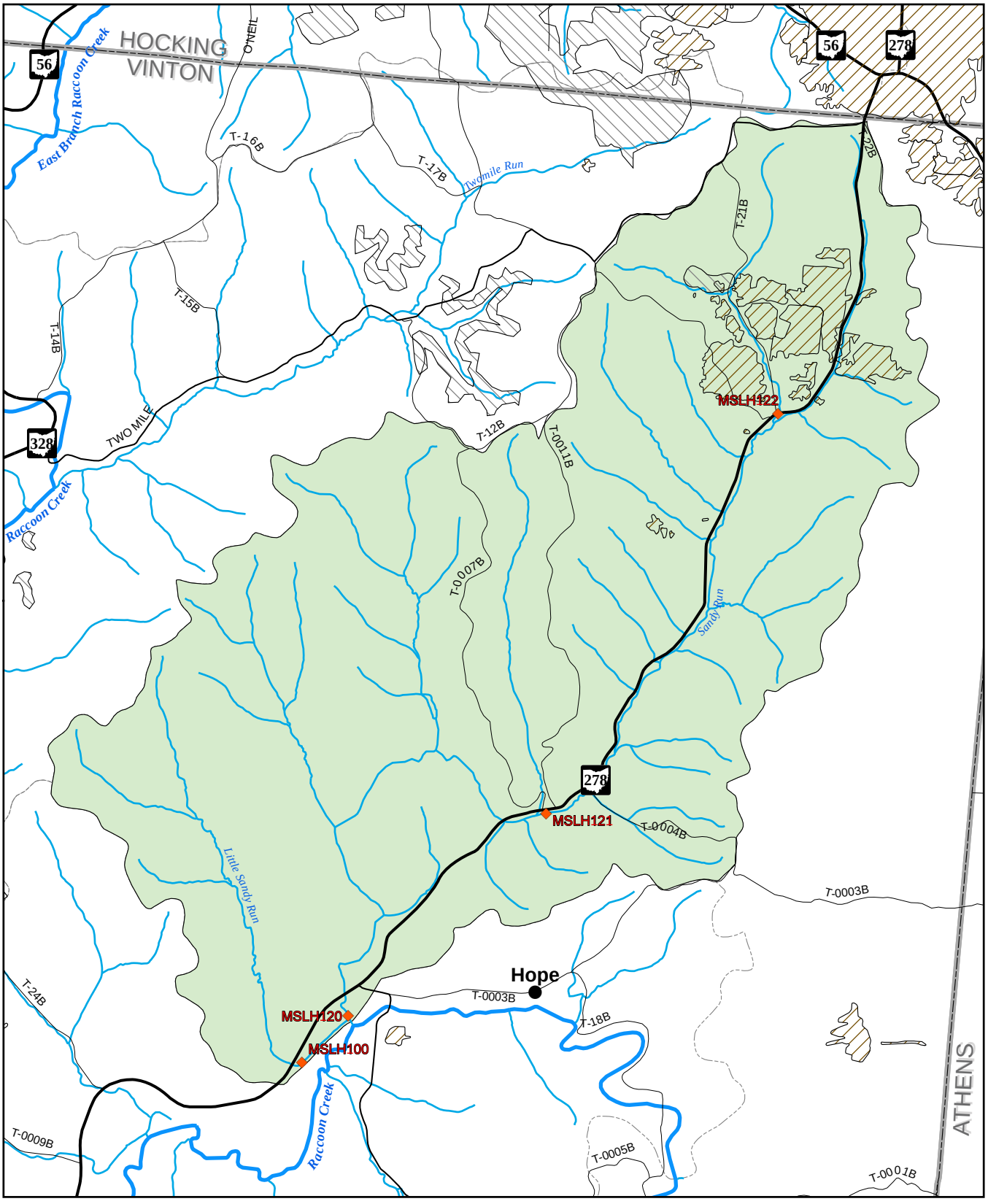
Miles

N

- Biological Sample
- Chemical Sample
- Surface Mine
- Underground Mine
- Streams
- County Rd
- Township Rd
- State Routes

Map 15 - Wheelabout Creek Subwatershed

14 DIGIT HUC - 05090101020050



Raccoon Creek Headwaters

0 0.5 1

Miles

N

- Chemical Sample
- Surface Mine
- Underground Mine
- Streams
- County Rd
- Township Rd
- State Routes

Map 16 - Sandy Run Subwatershed

14 DIGIT HUC - 05090101020070