Watershed Action Plan

Upper Big Walnut Creek Watershed
2011

Ed Miller – Watershed Coordinator, Delaware Soil and Water Conservation District

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Morrow Soil and Water Conservation District
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Ohio Department of Natural Resources
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United States Department of Agriculture
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Upper Big Walnut Creek Water Quality Partnership

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1.0 Watershed Overview for Upper Big Walnut Creek Watershed

Watershed Description

The Upper Big Walnut Creek (UBWC) watershed is characteristically rural, mostly agricultural with private residential distributed throughout. Residential and commercial development is changing the southernmost portion of the watershed and presenting some newer challenges commonly associated with growing communities in central Ohio. The Hoover Reservoir area at the southern extent of the watershed and the villages of Marengo, Sunbury, and Galena present the greatest non-agricultural water quality challenges.

Water quality impairments are discussed in detail in Chapter 4. The watershed has been the focus of numerous watershed studies further discussed in this chapter, including a Total Maximum Daily Load (TMDL). Generally speaking, water quality impairments are of greatest concern for drinking water supplies. Habitat degradation and sediment loading to streams, while discussed in detail in the TMDL report, has not been a subject of major concern to residents. Nutrients (nitrates and phosphates) and pesticides are commonly cited by residents as the most significant concerns. From an environmental perspective, the watershed continues to be listed on the Ohio Environmental Protection Agency 303(d) list of impaired watersheds. UBWC was identified as a priority impaired watershed by the Ohio EPA in their 1998, 2002, 2004, 2006, 2008, and 2010 303(d) lists (Ohio EPA, 2011) because it was not meeting established water quality standards. Excess nutrient concentrations (i.e., ammonia, nitrate plus nitrite, soluble reactive phosphorus, total phosphorus) occur regularly within the watershed, particularly within the headwaters (Ohio EPA, 2005).

The Upper Big Walnut Creek watershed drains approximately 190 square miles of predominately agricultural land across parts of five counties in central Ohio (map 1-1). The headwaters originate in Morrow County where the Big Walnut Creek flows 37.8 miles due south through Delaware County where it empties into the Hoover Reservoir in northern Franklin County. The Upper Big Walnut Creek watershed also includes small portions of Knox and Licking Counties. Big Walnut Creek continues to flow south out of Hoover Reservoir and eventually discharges into the Scioto River. This watershed action plan focus is on the area from the Headwaters to the dam on Hoover Reservoir.

The Upper Big Walnut Creek watershed is classified as an 11-digit hydrologic unit code (HUC). Hydrologic Unit Codes are used to identify watersheds throughout the nation where watersheds and their subwatersheds are organized into smaller units. As the size of the watershed decreases the HUC code increases. The Upper Big Walnut Creek watershed has been divided into eight separate 14-digit HUCs (map 1-2, table 1-1).

Table 1-1. Upper Big Walnut Creek 14-digit HUC Watersheds

Subwatershed # / name	14-digit HUC #(05060001130-***)	Square Miles	Acres	Counties
1 - Headwaters (Headwaters to above Culver Creek)	05060001130-010	55.09	35,230	Delaware, Morrow, Knox

2 – Culver Creek	05060001130-020	13.39	8,567	Delaware, Knox
3 – Perfect Creek	05060001130-030	10.02	6,410	Delaware, Knox, Licking
4 – Rattlesnake Creek and Tributaries	05060001130-040	22.76	14,565	Delaware, Licking
5 – Prairie Run	05060001130-050	8.60	5,506	Delaware
6 – Little Walnut Creek	05060001130-060	32.73	20,946	Delaware, Morrow
7-Hoover Reservoir Area	05060001130-070	29.75	19,039	Delaware, Franklin
8 – Duncan Run	05060001130-080	17.17	10,990	Delaware, Licking

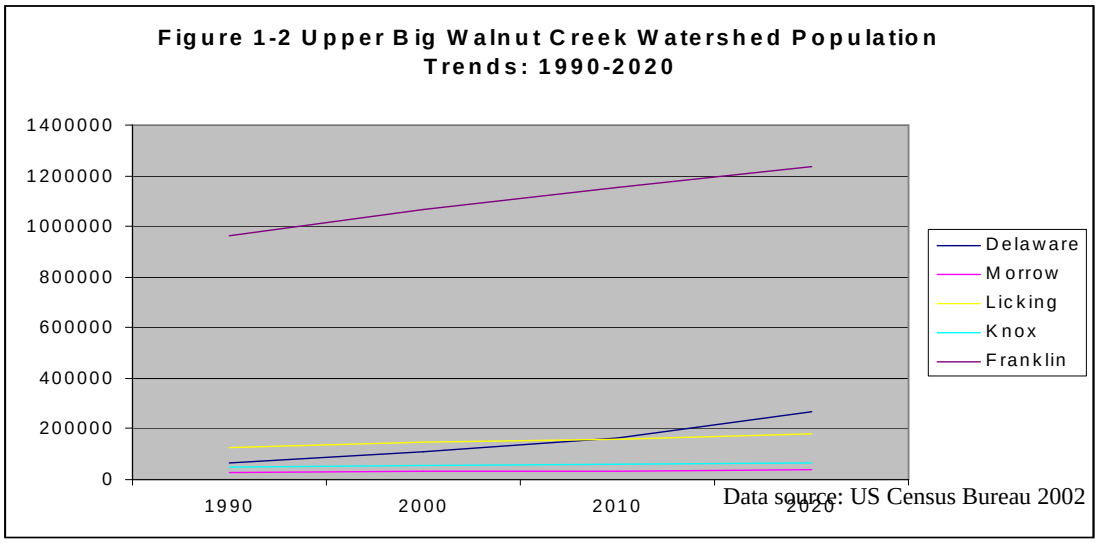
The main branch of Big Walnut Creek begins approximately 1.25 miles southeast of Mt. Gilead. From this point Big Walnut Creek flows due south through rural portions of Morrow County and through the Village of Marengo. According to the 2000 census, the Village of Marengo had an estimated population of 297 and an area of 0.2 square miles. The Marengo Waste Water Treatment Plant (WWTP) discharges into the Big Walnut Creek (permit # 4PA00101). The Big Walnut continues flowing south into Delaware County where it eventually flows through the villages of Sunbury and Galena. Sunbury is the largest incorporated village, by acreage, in the project area with a population of 2,630 and an area of 2.5 square miles (2000 census). The Village of Sunbury WWTP empties into Prairie Run (permit #4PB00010). The Village of Galena is the second largest incorporated village within the watershed with a population of 305 and an area of 0.6 square miles (2000 census). The Galena WWTP discharges into Big Walnut Creek (permit #4PB00106). There are several unincorporated areas within the watershed including, Stark Corners, Olive Green, East Liberty, Pagetown, Vals Corners, Bloomfield, North Condit, Condit, South Condit, Berkshire, Rome, Vans Valley, Center Village, Harlem, Mackstown, and Kingston Center. Ohio EPA Phase II Stormwater regulations do not apply to any of the incorporated or unincorporated areas in this study area. However, Genoa and Harlem Townships are considered Phase II communities.

Morrow, Delaware, Knox, Licking, and Franklin Counties each have a soil and water conservation district, Natural Resources Conservation Service Field Office, and Farm Services Agency office servicing their respective areas. Mid-Ohio Regional Planning Commission services all five counties within the study area. There are five park districts in the region servicing each county within the project area; Licking County Park District, Knox County Park District, Morrow County Park District, Preservation Parks of Delaware County, and Columbus Metro Parks.

Demographics and Economic Information

The population of this watershed is distributed through rural townships, small unincorporated areas, and the three villages of Marengo, Sunbury, and Galena. Although the UBWC watershed is considered an agricultural or rural watershed, the growth rate within the watershed was rapidly increasing before the housing market decline beginning about 2008. Delaware County is the fastest growing county in Ohio and has a 10-year population growth rate of 26.7 percent. Delaware County's close proximity to the City of Columbus is attributed to the increased growth

as Columbus experiences increased urban sprawl. Figure 1-2 illustrates the 10-year population growth rate of all five counties within the watershed. Because Delaware and Morrow Counties constitute nearly 87 percent of the watershed area, these two counties have the most influence on the demographic trends within the UBWC watershed.



Census data was analyzed in block groups and then clipped to the UBWC study area to estimate the population of the UBWC study area. The population in 2000 was 51,836 and the population for 2005 was estimated to be 63,299. This is a 22 percent increase over a five year period and closely resembles the same growth rate for Delaware County.

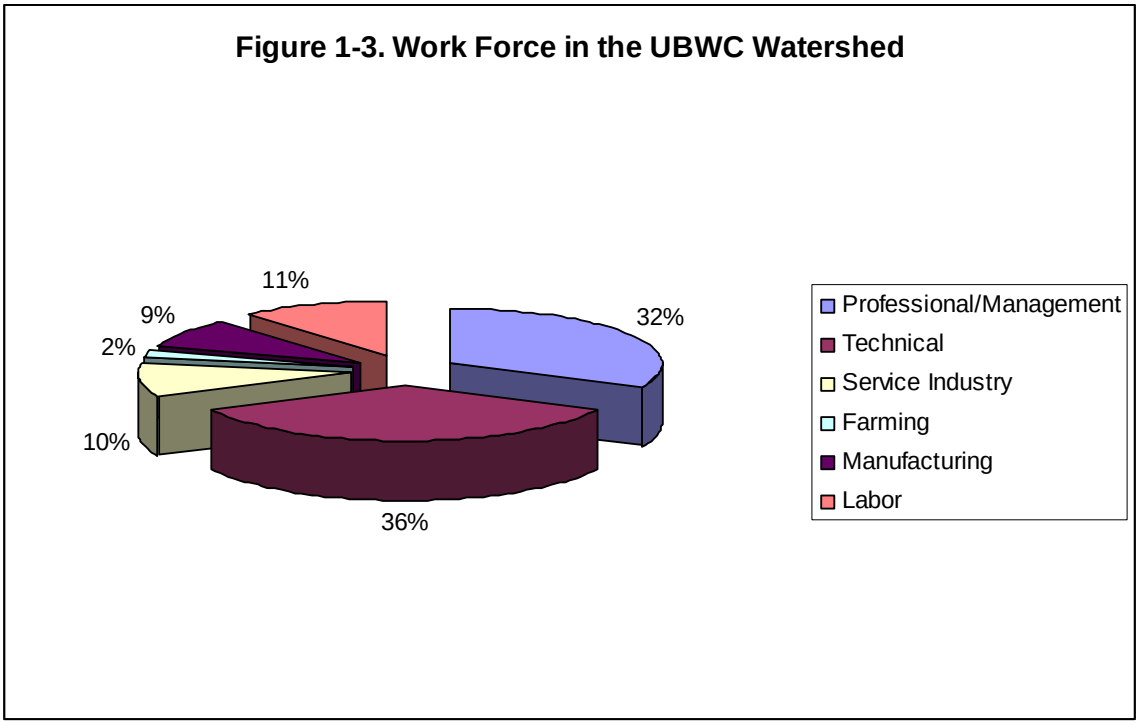
The land use changes necessary to support rapidly developing areas and an increase in population numbers can have an adverse impact on watershed health. Increase in impervious cover, greater stormwater volumes, and the destruction of wetland and riverine habitat leads to watershed health issues that are often difficult to address. Balancing the necessary growth with water resource needs is crucial to the overall health of the watershed and watershed communities.

According to the current land use analysis (1999-2003 OEPA-DSW), urbanized areas account for 14,993 acres or 12.37 percent of the UBWC watershed. Although, most of the developed areas within the watershed are centered within the villages of Marengo, Sunbury, and Galena, the townships of Harlem and Genoa in Delaware County are experiencing the highest growth rates. Harlem Township, at 51 percent and Genoa Township, at 21 percent, both qualify as Phase II stormwater communities. The majority of Harlem Township comprises subwatershed 070 and a portion of 080, while Genoa Townships land is split between the UBWC watershed (HUC 070) and the adjacent Alum Creek Watershed.

Employment

Over 70,507 acres (58.16 percent) of the watershed is in agricultural production (Row Crops: 55.25 percent and Pastureland: 2.90 percent). While agriculture is the largest land use in the watershed it constitutes a small portion of local employment. Percentages of employment by

sector for the watershed (figure 1-3) indicate professional/management and technical services are the largest employment contributors.



The median age for Morrow and Delaware Counties is 36.5 and 35.3 respectively which closely resembles the median age for the State of Ohio which is 36.2. The average household size for Delaware County is 2.70 while Morrow County has an average household size of 2.72. Both counties have an average family size of 3.09. The median household income for Delaware County is $67,258 with 3 percent of households falling below the poverty line. Morrow County's median household income is much lower at $40,882 and 6.6 percent of households fall below the poverty line. For the UBWC watershed, the median household income is $62,092. A total of 41 percent of the population over the age of 25 hold a bachelors degree or higher in Delaware County compared to 9.5 percent in Morrow County. The average for the State of Ohio is 21.1 percent.

Geographic Locators

Watersheds are identified using Hydrologic Unit Codes (HUC), which were created through the Federal Information Processing Standards. Major watersheds, for example, the Ohio Region, are assigned a 2-digit identification number. They are then subdivided into successively smaller hydrologic units by adding more digits to the original code number. The area of this watershed project occupies the northeastern portion of the Upper Scioto watershed (HUC-05060001), which is located in central Ohio (map 1-1). The project area is defined as the Upper Big Walnut Creek watershed north of the Hoover Reservoir dam in northern Franklin County. The watershed project spans approximately 190 square miles and is comprised of eight 14-digit HUC subwatersheds (map 1-2). Throughout this document each subwatershed is referred to by the descriptive name as found in table 1-1.

A portion of five different counties fall within the project area. Table 1-2 provides an account of each county's contribution in acreage and square miles to the project area, as well as the percentage of the county's area that is occupied by the watershed project. Maps detailing streams, roads, and other features of these subwatersheds are located in the appendices of this document.

Table 1-2. County and Total Watershed Area Breakdown

County	Acres in watershed	Sq. miles in watershed	Percent of watershed in county	Percent of county in watershed
Delaware	79,498	124.2	66	27.2
Franklin	1,797	2.8	1	.5
Knox	3,540	5.5	3	1.0
Licking	11,271	17.6	9	2.6
Morrow	25,271	39.5	21	9.7

Previous and Current Efforts to Meet Water Quality Standards

This section describes previous water quality protection, restoration, and management activities intended to meet water quality standards.

City of Columbus Comprehensive Waterways Management Plan, Phase One – Hoover Reservoir, March 28, 1990

This plan was developed as a Columbus Recreation and Parks Commission Project under the direction of Columbus Recreation and Parks Department Waterways Management Task Force, Thomas M. Stockdale, Chairman. According to the document the task force mission statement was as follows: " THE MISSION OF THE WATERWAYS MANAGEMENT TASK FORCE IS TO DEVELOP PLANS AND RECOMMENDATION FOR THE RECREATION AND PARKS COMMISSION DIRECTING THE COLUMBUS RECREATION AND PARKS DEPARTMENT TO TAKE APPROPRIATE STEPS TO PROTECT THE WATERWAY AND PARK RESOURCES IN CENTRAL OHIO, TO ENHANCE WATER QUALITY, AND MANAGE THE WATERWAYS FOR MULTIPLE USE RECREATION."

Upper Big Walnut Creek Watershed Conservation Reserve Enhancement Program (CREP)

The UBWC CREP program was in effect from 2002 through 2011. The goal of the UBWC CREP was to voluntarily reduce the amount of agricultural run-off containing sediment, nutrients and agricultural chemicals from entering the surface waters and ultimately the drinking water supply in the Hoover Reservoir. The initial goal was to install 3,500 acres of conservation practices including:

- riparian buffers,
- filter strips,
- hardwood tree plantings,
- permanent wildlife habitat,
- wetland restoration and
- perpetual easements.

Initially, to encourage the best use of buffers, there was a one-time local supplemental payment of $60 per acre available to landowners who enrolled a minimum average buffer width of 66 feet adjacent to watercourses. This minimum width corresponds to the label directions for atrazine application as a restricted use pesticide because of ground and surface water concerns. This program continued to fund buffers up to an average maximum width of 200 feet since the watershed is a major raw drinking water supply. As of October 31, 2010 about 530 acres of conservation practices (filter strips) have been enrolled in the Upper Big Walnut Creek CREP.

Current Efforts to Meet Water Quality Standards

This section describes current water quality protection, restoration, and management activities and programs intended to help meet water quality standards.

In the past, agencies have led the effort in improving water quality within the UBWC study area. Agencies that are currently working towards improving the UBWC watershed are: Ohio Department of Natural Resources, USDA-Natural Resources Conservation Service, Soil and Water Conservation Districts, Ohio Environmental Protection Agency, and U.S. Environmental Protection Agency, City of Columbus, Division of Power and Water, U.S. Fish and Wildlife Service, and the U.S. Geological Survey. So far, there has been limited involvement from the non-profit sector. However, citizens groups, such as the Big Walnut Creek Water Quality Partnership and local high school science departments have been involved in planning and monitoring projects.

City of Columbus, Division of Power and Water

The City of Columbus has been instrumental to the success of several water quality implementation programs within the UBWC study area. As Hoover Reservoir is the main water source for city residents, the city has a vested interest in the overall health of the watershed. The City conducts water monitoring at Hap Cremean Water Plant along with other sites within the Hoover Reservoir. The City also is able to hold conservation easements and has been working to secure easements within the UBWC watershed along its surface waters. Columbus has provided matching funds for the Upper Big Walnut Conservation Reserve Enhancement Program and Environmental Quality Incentive Program and other watershed education and outreach efforts.

Delaware General Health District (DGHD)

The Delaware General Health District has developed an Household Sewage Treatment (HSTS) Plan to improve, protect and preserve water quality in Delaware County, and to protect public health and improve the quality of life. The plan was developed, in part, to meet the anticipated rapid population growth of the county.

Recent Plan improvements include:

- Review and update current regulations to meet state sewage regulations and add new proven technology for the installation of HSTS in current regulations.
- Provide assistance to watershed coordinators with the implementation of their approved action plans, and to provide assistance to coordinators that are in the process of submitting their action plans and inventory lists.

- Continue to complete a HSTS database which will incorporate such information as year of HSTS installation, type of HSTS, date of last inspection, date last pumped out, and sampling results.
- Inventory all 18,500 HSTS installations into the database. Currently, 9,169 HSTS inventories are in the HDIS database, which represent those HSTS that were installed post-1988. Approximately 10,000 HSTS remain to be entered in the database. In some instances a field evaluation may be required to determine the type of HSTS, the home address, and the location on the lot of the HSTS installation. Many older HSTS permits lack adequate data.
- All 18,500 HSTS are to be geo-coded.
- Inspect the 250 semi-public sewage systems under a contract with Ohio EPA. On-lot systems are inspected once every three years, and package plants once a year.
- Base HSTS inspections on watershed priorities using EPA's TMDL reports. All failed HSTSs will be documented and enforcement procedures for correction implemented. From 2005-2008, 3,951 HSTS have been inspected with 126 systems in need of repair or replacement. Those systems have been brought into compliance.
- Inspect 10% of the 3,000 discharging HSTS in Delaware County annually. The priority areas for inspection will be the HSTS that directly outlet into a watershed or tributary that enters the watershed. All failed discharging HSTSs will be documented and enforcement procedures for correction implemented.
- Strengthen inspection policies, procedures, and enforcement of failing HSTS with the County Prosecutor.
- Upgrade or replace existing failed HSTS in the documented areas of existing need as determined by the DGHD. When installation of a centralized treatment system is not Delaware County HSTS 2004 Plan feasible or is not available, one of the three options in the following order of priority will be determined:
    1. Additional leaching lines less than full replacement with current maximum trench depth to at grade leaching or other on-lot systems (including experimental systems.)
    2. Class I NSF Standard 40 Aerator with Chlorinator to (direct access) intermittent stream with continuous service contract.
    3. Subsurface Sand Filter with Chlorinator to (direct access) intermittent stream or drainage way with functioning (and in proper repair) and properly sized septic tanks.
- Assist homeowners in identifying financial assistance to repair or replace their existing HSTS or convert to available sanitary sewer.
- To continue to work collaboratively within the community to improve, protect, and preserve water quality with watershed coordinators, elected officials, local zoning boards, Delaware County Regional Planning Commission, Delaware Soil and Water Conservation District, Sanitary Engineers, Ohio EPA, ODNR, ODH, ODA, FACT, FLOW, and Scioto River Valley Federation.
- To continue to encourage the expansion of Delaware County sanitary sewer, and to continue to provide data for justifying the need for expansion of Delaware County sanitary sewer.
- To continue to encourage expansion of the existing WWTPs in Delaware City and at the Delaware County Treatment plants.

- To update sampling policies and procedures, and to collect new and existing data on stream water quality within the watersheds including BOD, TSS, fecal coliform and ammonia with the approval and assistance of volunteers.
- To design, and conduct stream water sampling study with the Ohio EPA that would document improvements in the water quality over time with causation linked to repair and replacement of existing failing HSTSs. Compare previous Ohio EPA biological and water quality reports with current sampling results.
- To continue to provide annual HSTS operation and maintenance workshops with watershed coordinators for residents along with other educational and informational programs and services.

The DGHD has regulated the disposal of wastewater from HSTS since the early 1900's. The local HSTS regulations for DGHD are based upon the minimum standard found in OAC 3701-29, which was promulgated under Public Health Council authority for sanitary rules, ORC Section 3701.34(A). In the early 1980's, the Delaware Board of Health adopted local regulations for the HSTS program.

Many amendments to the state minimum standards, and new policies that the BOH adopted were done over the years to improve the installation of HSTS based on further technical research, and on field studies conducted in Delaware County. Other information concludes that Delaware County's topography and geology reveals that only 52% of the land is suitable for on-site sewage systems. The OSU Extension Service reported that only 2 % of the soils in Delaware County are suitable for traditional on-lot leach lines, and only 14.7% of Delaware County soils are suitable for Wisconsin mound systems.

In 2005, in anticipation of state rules changes, local sewage rules were revised and adopted by The Board of Health. In 2008 the Ohio Department of Heath adopted statewide sewage rules. Unfortunately, these rules were soon rescinded for statewide use, but DGHD Board of Health readopted them for local use. These rules require site specific soil reports and individually designed sewage systems based on the results of the soil report. Elevated sewage systems such as drip distribution and mound systems have become more common than ever. However, depending on the soil report, a leach sewage system can still be approved. With all the options available in these rules, variances for the type of sewage system are rarely needed. Off lot discharging systems now must have an NPDES permit issued by the Ohio EPA. However, due to the on-lot options available, off-lot systems have become less common than ever before. DGHD has issued 3 off-lot sewage system permits in the past three years.

In addition to strengthening our local sewage regulations in order to improve our program and affect water quality, we have established an excellent working relationship with other governmental agencies in our County such as Delaware County Regional Planning, watershed coordinators, Delaware County Soil and Water Conservation District, County Commissioners, Township Trustees and environmental interest groups such as FLOW, FACT, Scioto River Valley Federation, and OWA.

In 2002, DGHD began working with watershed coordinators to assist in developing Ohio EPA watershed action plans to address impairments that impact the watersheds in Delaware County, which include failing HSTS. DGHD has also cooperatively provided quarterly homeowners operation and maintenance HSTS workshops in conjunction with our watershed coordinators. The DGHD anticipates further collaboration in homeowner educational and awareness programs and services in the future.

Along with the watershed partnerships that have been established, the DGHD has worked collaboratively with and have been instrumental in assisting with the development of the master plan for sanitary sewer expansion for Delaware County. The team reviewed population projections, current development patterns, adopted land use plans and local zoning and then met with local officials to create a future density map. Health Department staff performed surface water sampling in non-sewered older neighborhoods to test for potential surface water pollution. Series of maps were created, including a sewer service priority map and a future potential sewer service map. The master plan has been finalized, and has received approval from the County Commissioners. During this process, the DGHD identified “areas of existing need”, using criteria such as visual inspections, fecal coliform sampling results, age of the HSTS, lots size, soil type, and if the lot had a discharging HSTS. The areas of existing need are clearly outlined in this document. The anticipated date of completion of the proposed sanitary sewer will be in the year 2015. However, many of the areas of existing need may not be serviced with the proposed sanitary sewer expansion.

The DGHD have also developed additional capacities by learning new technologies such as GIS and GPS technology. The DGHD spoke at the 2004 OEHA Annual Educational Conference about the exceptional collaboration, and planning efforts for meeting the sewage needs for our

immense population growth in the fastest growing county in the State of Ohio. The DGHD will continue to provide this information for other health departments that may need assistance.

Through their litter prevention and recycling program, annually they provide a watershed debris and tire cleanup with approximately 60 volunteers and the watershed coordinators. Every two years, the DKMM solid waste district sponsors the household hazardous waste program to collect hazardous waste in order to protect water quality.

The local regulations will expand the use of alternative soil-based systems and limit the use of discharging aeration systems and the traditional deep trench soil-based system. The use of a septic tank with a pre-treatment alternative prior to soil absorption will prevail as the treatment of choice in soils with high seasonal water tables and slow permeability. Pretreatment will take place in aerobic environments such as the aeration system, and manufactured, sealed, intermittently dosed sand and peat bioreactors. The Wisconsin Mound System pre-treats above the soil absorption interfaces, and will be one of the desired future systems, and has shown good performance. The soil absorption interface will be above, at, or just below the virgin ground surface using irrigation, drip irrigation, shallow trench or at-grade systems. Treatment to acceptable limits of bacteria/viruses, TSS and BOD will take place before effluent is placed into the soil for dispersion and/or further treatment or discharged off lot.

In addition to the proposals listed above, their local regulations are to:

- Establish separation distances between the bottom of the distribution system and the limiting layer (i.e., seasonal high water table, fragipan, bedrock) based upon the elevation of the distribution system, the type of distribution system, the quality of pre-treatment, and the maximum loading rates for characterized soil conditions;
- Establish effluent standards based upon the method of on-lot disposal and maximum loading rates for characterized soil conditions; and
- Require management programs to be in place which assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems using the private sector service industry or established local health district operation permit inspection programs;
- Identify an acceptable outlet for a discharging system;
- Specify loading rates and soil absorption area requirements based upon soil characteristics;
- Limit the time of year a soil-based system can be installed, based upon soil wetness;
- Enhance the current DGHD Basic System Assessment (BSA) program by requiring operation and maintenance contracts by private sector service contractors, sampling on all new discharging or mechanical/electrical systems; and regular homeowner education.
- Enhance the current requirements for subdivision approvals;
- Regulate the construction and method of effluent distribution including gravity flow, drop box distribution, equalized pressure distribution, dosing (timed and on-demand), drip irrigation, spray irrigation, level ground distribution and others;
- Eliminate a minimum lot size for HSTS, if all of our HSTS rules can be met;
- Require at least three feet of unsaturated soil as the treatment media for septic system effluent or require pretreatment to a specified effluent quality if there is less than three feet of virgin soil filter media; and

- Specify the corrective measures that will be approved when upgrading a failed soil-based HSTS.

Additional anticipated results include that all 18,500 HSTS will be identified, inventoried and inspected. All failed HSTS will be upgraded by connection into central sanitary sewers, or package plant when possible; or upgraded with on-lot HSTS appropriately designed to overcome site limitations such as soil permeability, depth to bedrock, depth to seasonal high water table, depth to dense till, slope; or other on-lot system with newer technology such as Wisconsin Mound System; or upgraded with a Class I NSF Standard 40 Aerator with chlorination or replaced with a subsurface sand filer with chlorination to (direct access) intermittent stream or drainage way with functioning and properly sized septic tanks.

New or existing communities or groups of single family dwellings with failed HSTS may be tied into a community sewage treatment and disposal system using the following alternatives:

1) high technology treatment plant discharged to lagoon then to an irrigation system ("land application").
2) wetland or sand bio-reactor pre-treatment systems discharged in soil-based treatment and disposal systems, such as mound systems, surface or sub-surface irrigation systems; or,
3) Off-lot HSTS shall not be considered for newly created lots.

Delaware County will also be successful in the expansion of central sanitary sewer to service southern Delaware County. The WWTPs of Delaware City and Delaware County Treatment plants will be successfully expanded to increase capacity.

Ohio Department of Natural Resources, Division of Soil and Water Resources; Ohio Agriculture Pollution Abatement Program (APAP): Ohio's Agricultural Pollution Abatement Program (APAP) may provide farmers with cost share assistance to develop and implement best management practices (BMP) to protect Ohio's streams, creeks, and rivers. This program has been successful in helping to alleviate concerns associated with agricultural production and silvicultural operations which can create soil erosion and manure runoff.

The APAP is administered by Ohio Department of Natural Resources-Division of Soil and Water Resources and implemented locally by Soil and Water Conservation Districts (SWCD). Farmers wanting to know more about the program need to contact their local SWCD for technical and potential financial assistance. Dependent upon the BMP being installed, the program offers three levels of funding caps. Currently, each funding level has a 75% cost share rate "not to exceed" a total of $15,000 per producer per year.

Ohio Environmental Protection Agency; Total Maximum Daily Load (TMDL) for the Upper Big Walnut Creek: The Ohio EPA completed the TMDL for the Big Walnut Creek Watershed, which includes the Upper Big Walnut Creek subwatershed, in August of 2005.

The TMDL process uses water and sediment chemistry, physical measurements, and biological indicators to assess water resource quality. These assessments allow Ohio EPA to determine which reaches of streams do not meet water quality standards, and what the causes and sources

of the impairments are. Quantitative pollutant reduction from point and nonpoint sources will be allocated necessary to meet water quality standards. These are actual values of pollutes or physical measurement a stream must meet to be considered healthy. TMDL process uses water quality models to take the multiple sources into consideration and also to determine reduction scenarios utilizing various conservation practices and changes to surface water discharging permits.

Upper Big Walnut Creek Water Quality Partnership: This partnership is an all-volunteer consortium of farmers, landowners, businesses, government agencies, and natural resource professionals. It was formally organized in September 1997, largely in response to water quality problems that impacted the integrity of the Big Walnut Creek watershed as a drinking water resource for the City of Columbus. The goals of the partnership have been to improve the water quality of the Upper Big Walnut Creek and tributaries through effective conservation practices while sustaining profitable agriculture within the watershed. Collaborators with the Upper Big Walnut Creek Water Quality Partnership:

- US Geological Survey
- US Forest Service
- Ohio Professional Applicators for Responsible Regulation
- Ohio Department of Agriculture
- Ohio Department of Natural Resources
- Ohio Environmental Protection Agency
- Ohio State University Extension
- Ohio Farm Bureau Federation
- Farmers
- Landowners
- Private Businesses
- City of Columbus
- Farm Service Agency
- Natural Resource Conservation Service
- Soil & Water Conservation Districts
- US Agricultural Research Service

USDA Conservation Reserve Program (CRP) is an environmental improvement program that uses financial incentives to encourage the establishment of permanent covers of grasses and trees on environmentally sensitive lands. It is administered through the USDA Farm Services Agency with technical assistance from the Natural Resources Conservation Service. The program protects the soil from erosion, increases wildlife habitat, and protects ground and surface water by reducing water runoff and sedimentation (USDA 2001).

USDA-NRCS Environmental Quality Incentive Program (EQIP) is a USDA cost share program. This program can be used for any USDA cost share practice including, but not limited to, animal waste storage facilities, grid sampling and nutrient management, compost facilities, grassed waterways, and cover crops.

USDA –NRCS Mississippi River Basin Initiative – Cooperative Conservation Partnership Initiative (MRBI-CCPI)

This project utilizes innovative nutrient reduction practices and technologies in the Upper Big Walnut Creek watershed to help avoid, trap, and control nutrients from agricultural operations. Nutrients from cropland runoff and agricultural drainage systems that enter waterways can degrade drinking water quality in the Hoover Reservoir and prevent streams from attaining water quality standards.

A diverse collaboration of project partners is comprised of governmental and private sector conservationists and include the Delaware Soil and Water Conservation (SWCD), District, Morrow Soil and Water Conservation District, Iowa Soybean Association, Environmental Defense Fund, Ohio Farm Service Agency, Ohio Natural Resources Conservation Service, and USDA-Agriculture Research Service, Soil Drainage Research Unit as well as local farmers in the watersheds.

Project work focus' on two subwatersheds within the watershed, including the mainstem and headwaters of Upper Big Walnut Creek in Morrow, Knox and Delaware counties and Big Walnut Creek below Little Walnut Creek to Hoover Reservoir in Delaware County.

The objective of this MRBI-CCPI project is to leverage existing planning and studies that partners have undertaken in the watershed and move toward implementation and engagement with landowners and producers. The watershed project office, based at the Delaware County SWCD, will serve as the Project Director/Manager for the project.

Engagement with producers is accomplished through targeted outreach and quality technical assistance to generate higher levels of key conservation practice implementation in the two target subwatersheds. The outreach and technical assistance will also aim to involve farmers in a nutrient efficiency network called the On-Farm Network®, which advances an adaptive management approach to nutrient management that delivers a higher level of farmer engagement, more sustained improvements in nutrient use efficiency, and increased accountability and validation of impact. More information about the On-Farm Network® is on the web at http://www.isafarmnet.com/.

Partners work with producers to promote and install, in key locations, conservation practices and agronomic best management practices identified by watershed partners and assessments as being most effective in delivering water quality benefits in these areas - primarily cover crops, reduced tillage and agriculture drainage water management. The project also advances improved implementation of buffer practices (filter strips, grassed waterways, critical area plantings) offered through the USDA Conservation Reserve Enhancement Program. The overall objective of the project is to achieve meaningful and documentable water quality improvements in local streams that both supply drinking water to citizens and ultimately drain into the Mississippi River basin.

To date, most of the work in the watershed has focused on gathering information and formulating plans, and partners are now developing a strong best management practice implementation program aimed specifically at producers in the watershed that this project supports. The extensive research and work already underway in the watershed, the Watershed Project

Coordinator Grant, and the strong interest Columbus has in protecting and improving the Hoover Reservoir has made the watershed an ideal location for partners to promote greater adoption of conservation in strategic locations to address identified water quality problems. Full details on the Mississippi River Basin Initiative are located on the web at:
http://www.nrcs.usda.gov/programs/

USDA-NRCS Upper Big Walnut Creek Special EQIP
The Upper Big Walnut Creek Watershed *Special* EQIP is a voluntary conservation program that promotes agricultural production and environmental quality as goals for producers. Through *Special* EQIP farmers may receive financial and technical assistance to help with precision nutrient management and atrazine herbicide reduction on their land. Applications were accepted from February 12, 2007 to April 20, 2007.

The following practices are eligible for funding through the *Special* EQIP program:
Nutrient Management (manure)
Precision Nutrient Management
(Variable rate fertilizer application)
Conservation Crop Rotation
Residue Management, No Till
Cover Crop
Grazing Management
Structure for Water Control
Drainage Water Management

Work was completed on applications for the 2008 contracts outlining plan implementation over the next 3-4 years. Delaware County had 34 tracts under contract totaling 3,832.7 acres for 2007. Morrow County had contracts on 49 tracts with 2,890.6 acres. Knox County had 12 tracts under contract for 301.3 acres. This is a total of 7,024.6 acres. In 2008, Delaware had 32 active contracts for the practice implementation with 3,731.5 planned acres and Morrow County had 27, and Knox County had 7 contracts for a total of 6,255.4 acres.

USDA-NRCS Wetland Reserve Program (WRP) is a nationwide voluntary conservation program that offers landowners the means and the opportunity to protect, restore, and enhance wetlands on their property. The USDA, Natural Resources Conservation Service (NRCS) manages the program as well as provides technical and financial support to landowners who participate in WRP. Additional benefits of the WRP include: improved water quality, enhanced habitat for water fowl and endangered species, enhanced habitat for other wildlife, reduced soil erosion, improved water supply, reduced flooding. (USDA 2001).

USDA-NRCS Wildlife Habitat Incentive Program (WHIP) is a USDA program that offers landowners cost share assistance for grassland plantings, riparian tree plantings and wetland restoration to benefit wildlife.

Watershed Studies and Research

Antibiotics and Wastewater Compounds in Source and Finished Drinking Water from the Upper Scioto River Basin, Central Ohio (In cooperation with the City of Columbus, Division of Power and Water.)

As a result of recent attention on the issue of emerging contaminants in public water supplies, the City of Columbus, Ohio, has received inquiries regarding the presence of antibiotics, pharmaceuticals, and other wastewater compounds in City water supplies. A national reconnaissance study completed during 1999-2000 revealed that a variety of compounds including antimicrobials, detergents, disinfectants, fragrances, fire retardants, prescription and non-prescription drugs, can enter streams and ground water. These wastewater compounds can be released into the environment by wastewater-treatment plants (WWTPs), animal feed lots (AFOs), discharges from industrial facilities, septic disposal systems, or from land application of sludge, biosolids, or animal waste. Little is known about the occurrence, fate, or transport of these compounds and the possible health effects linked to human and aquatic life. Some of these compounds are endocrine disruptors and have been linked to negative hormonal and toxic effects in aquatic organisms; others are suspected of increasing antibiotic resistance in bacteria in the environment.

Eighty-five percent of the City's annual water supply (roughly 27 billion gallons of water) is drawn from three reservoirs in the Upper Scioto River Basin. This portion of the basin contains several large WWTPs and AFOs that discharge into the Scioto River. On the basis of previous studies and the belief that wastewater contaminants are derived from both urban and agricultural sources (including treated sewage effluent and runoff from AFOs), the potential exists for wastewater contaminants to be present in source waters in the Basin used to supply drinking waters to residents.

The objectives of this project are to determine the occurrence and concentration of antibiotics and wastewater compounds in source waters from the Upper Scioto River Basin, and determine if antibiotics and wastewater compounds are present in drinking-water supplies before and after treatment.

Note: The United States Geological Survey has a stream gauging station on the Upper Big Walnut Creek 200 feet downstream of the State Route 37 bridge. This station is located in Trenton Township on the southeast side of Sunbury. Real time data is available for the following parameters; gage height, discharge, water temperature, specific conductivity, dissolved oxygen, and pH. Data is available from October 1988 to present.

The study includes the following:

- Depth- and width-integrated stream samples collected from the following locations: Powder Lick near Somersville, Mill Creek below Marysville, Scioto River near Prospect,

Big Walnut Creek at Sunbury, and the Scioto River adjacent to the Columbus Well-104.

- Paired source and finished drinking water samples collected at three City of Columbus Water Treatment Plants: Dublin Road, Hap Cremean, and Parsons Avenue.

- A ground-water sample collected from a production well at the Columbus South Well field.

- Samples were collected during or immediately after rainfall events in an effort to target periods before, during, and after application of manure in the watershed. In addition, low-flow samples were collected in late summer when treated wastewater and septic tank discharge are thought to represent a larger proportion of the total streamflow than during periods of higher flow.

- Samples were analyzed for 49 antibiotics by the Organic Geochemistry Research Lab in Lawrence Kansas, and 59 wastewater compounds by the National Water Quality Lab in Denver, CO.

This project is ongoing and a full report is available at http://pubs.usgs.gov/sir/2010/5083/. For more information regarding this project, contact Dennis Finnegan at **dpfinneg@usgs.gov** or (614) 430-7731.

More information regarding emerging contaminants and other USGS projects can be obtained by contacting Greg Koltun at **gfkolton@usgs.gov** or (614) 430-7708.

Factors affecting natural resource conservation investments of residents in the Lower Big Walnut Creek watershed, Ohio

During the fall of 2005 and early winter of 2006 data were collected from adults living within the Lower Big Walnut Creek (UBWC) watershed to evaluate their willingness to allocate economic resources to implement soil and water conservation programs on their properties. A total of 149 questionnaires were returned of the 348 sampling frame for a 41.8 percent response rate. Of the total participants, over 60 percent indicated they were "not willing to invest" in conservation – not even one dollar on their own property.

Of the summary and conclusions drawn from this study were several scenarios depicted that indicated farmers in the Upper Big Walnut Creek watershed and urbanites downstream may develop a potentially "problematic" relationship. Specifically, should downstream conservation efforts to increase willingness of urban land owners to invest in conservation prove successful then it is highly likely that urbanites will expect upstream farmers to increase conservation practice adoption as well. According to the study, "Such a situation could result in urban residents demanding that farmers within the Upper Big Walnut Creek watershed (from Hoover Reservoir north through two counties) to comply with the environmental quality expectations held by urban residents.

To date, there is little evidence to support the development of scenarios where such conflicts have emerged between UBWC farmers and their downstream suburban residents. The failure of these potentially adversarial scenarios to develop as suggested by the study may be due in part to the continued resistance of urbanites to adopt conservation practices and unite in any concerted effort against farmers on one hand and by the implementation of a host of water quality improvement practices by upstream farmers on the other hand (Journal Soil and Water Conservation 2008).

Ohio State University, Ohio Agricultural Research and Development Center (OARDC) proposes a feasibility study to conduct an economic and pollutant assessment that will estimate the potential costs and benefits of water quality trading in the Upper Scioto Watershed. The main drivers of the potential trading plan, which is based on a partnership between the city, SWCDs, and OSU are the high costs of upgrading the City of Columbus's existing WWTPs and drinking water facilities. Other watershed WWTPs will be included in the study. OARDC/Ohio State University, the City of Columbus Public Utilities, and the Delaware County SWCD will coordinate the project with the help of the Ohio Department of Natural Resources. Other partners will include county SWCDs, NRCS, and other farming and rural associations and agencies in the watershed. The project will conduct a willingness-to-pay study to determine the potential costs and benefits for the City of Columbus of water quality trading in the Upper Scioto as well as a study of current agricultural practices and the willingness of farmers to implement credit-generating conservation measures. This latter objective is to identify the conditions needed to motivate farmers to adopt the proposed conservation measures. Furthermore, through spatially and temporally intensive water quality sampling, the project will undertake a pollutant suitability analysis that will identify the current status of phosphorus, nitrogen and sediment pollutants in the watershed and establish a pre-trading pollutant baseline.

USDA Agriculture Research Service – Soil Drainage Research Unit

The Agriculture Research Service plays a very active role in the watershed through their Conservation Effects Assessment Project and Source Water Protection Initiative which includes conservation practice assessment, aquatic ecology, managed turf, urbanization, and drainage filtration. The mission of the research unit is to: "Develop and demonstrate integrated water management, conservation management, and cropping management systems that support profitable agriculture and environmental protection."

For more specific information on the work of the Soil Drainage Research Unit in the watershed go to: http://www.ars.usda.gov/main/site_main.htm?modecode=36-04-00-00

2.0 Watershed Action Plan Development

The Upper Big Walnut Creek Water Quality Partnership was formally organized in 1997 in response to high levels of atrazine in the Hoover Reservoir. The group, consisting of landowners, businesses, local and state agencies, and community organizations, worked collaboratively to develop a water quality management plan which would address agricultural pesticides in the Upper Big Walnut Creek watershed, a primary source of drinking water for the city of Columbus. Since the completion of the *Upper Big Walnut Creek Watershed Water Quality Management Plan* in 1999, the Partnership has implemented two special EQIP programs and the UBWC CREP. Agricultural best management practices have been utilized watershed-wide for over 10 years with measured success. However, the water quality management plan had a fairly limited focus and was not a comprehensive watershed action plan. As a broader range of water quality concerns were being identified in the watershed, Partnership attention turned to discuss and address these concerns. Subsequent discussions with numerous other watershed stakeholders identified a need to go beyond the goals and objectives of the water quality management plan. In 2006 the Delaware SWCD decided to apply for an Ohio Department of Natural Resources Watershed Coordinator Grant to develop a comprehensive watershed action plan to address the broader range of water quality impairments identified in the watershed. In 2007 the Delaware SWCD was awarded a four year planning grant to assist in employing a full time coordinator to develop a state endorsed watershed action plan using *A Guide to Developing Local Watershed Action Plans in Ohio*.

Watershed Partners

The Partnership and the Delaware SWCD Board of Supervisors recognized the need for the coordinator to work more closely with other watershed stakeholders and resource specialists. A process began to build a wider network of stakeholders with the capacity develop an action plan that would address a comprehensive and complex suite of water quality impairments in the watershed. An initial step was to draw broader support from Partnership members and then collaborate with other key resource and agency personnel who had related environmental health, public health, educational, water-related recreational, and water quality research agendas. Each of these key stakeholders brought with them their own network of resource individuals and community members with a vast amount of experience, expertise, and interests in improving and protecting water resources. Among some of the most active local partners in watershed planning have been the soil and water conservation districts, USDA Natural Resource Conservation Service, Farm Services Agency, and Agricultural Research Service, the City of Columbus Watersheds and Water Quality Lab staffs, and health district staffs.

In general, other local participants and supporters in the planning process have come from residential homeowners, businesses, agricultural landowners, community organizations, educational institutions, engineers, park managers, homeowner associations, golf course managers, township officials, agricultural industry and organizations,

Mission Statement

To develop partnerships with watershed stakeholders in order to create and implement a watershed action plan to improve and maintain the water resources of the Upper Big Walnut Creek Watershed Project area.

Organizational Structure

This watershed project, which entails development and implementation of the watershed action plan is structured at a program level under the Delaware Soil and Water Conservation District governed by a Board of Supervisors. The watershed coordinator is employed by the Delaware SWCD Board with guidance and assistance provided by an Area Assistance Team consisting of representatives from the Ohio Department of Natural Resources, Division of Soil and Water Resources, Ohio State University Extension, and Ohio Environmental Protection Agency. Subcommittees of the Board gather public input and participation and assist in advising and subsequent planning. Standing subcommittees are the agriculture committee, drainage committee, education committee, and streams and watersheds committee. The watershed project is further advised by a voluntary collaboration of professional, technical, and managerial individuals who meet quarterly to discuss and report on relevant watershed, water quality, and program topics. An informal technical committee meets or communicates frequently to discuss and address issues primarily related to watershed research, Farm Bill programs, drainage issues and other matters of a technical nature. Smaller, topic specific, work groups are formed as needed to advise on emerging issues or revisit persistent concerns.

Public Participation

A strategy for voluntary public participation in watershed planning and implementation has been developed to include a broad base of representation from diverse watershed communities. An extensive range of opportunities are made available to attract interested participants. These opportunities evolve over time and are flexible enough to meet the changing needs of the iterative planning and implementation process. Participants in the planning process include individuals and organizations that use the resources in the watershed and have an interest in identifying and solving water resource problems. These stakeholders include individual citizens, local elected officials, state and federal resource agencies, water suppliers, developers, golf course managers, farmers, public and environmental health specialists, educators and students, parks and recreation managers, regional planners, engineers, conservationists and conservation technicians, water quality researchers, and rural drainage specialists.

The watershed project places strong emphasis on measurable results in water quality and designs projects and conservation programs to accomplish these goals and objectives. However, limited resources and priorities must be balanced and manageable. Targeting priority sub-sets of high-magnitude causes of water quality impairment listed in the TMDL involves coordinated efforts with different individuals, groups and teams in different areas of the watershed at different times. Consequently, efforts to engage the public in planning and implementation strategies often must follow targeting activities and schedules throughout the entire watershed.

Participation in a public forum does not always elicit the most productive planning strategies. Many times it proves more successful to meet and discuss concerns and strategies on an individual or in very small group setting. When key stakeholders are identified that have the

potential to provide useful assistance, yet are unable to become involved publically, special efforts are made to work with them individually or in small group settings at the participants convenience. Some of the most productive strategies in the watershed come about by keeping numerous individuals and small groups coordinated without the necessity to conduct large, time consuming gatherings.

Group Decision- Making Process

All final decisions for the watershed project at the program level are made formally by the District Board of Supervisors. The quarterly Partnership meetings serve as the primary advisory committee for the project and provide direction for many project activities, identification of priorities, providing suggestions and informal recommendations. In addition, standing committees of the Board conduct annual meetings to gather community input, review accomplishments, and identify priorities. Results of community environmental surveys, specialized surveys, and community and regional planning goals further support the watershed project decision-making process. Watershed research results and regulatory issues also play a significant role in the decision-making and planning process.

General Plan Contents

The Upper Big Walnut Creek Watershed Action Plan is a comprehensive and dynamic document that follows the watershed approach set forth in guides developed by the Ohio Environmental Protection Agency and USEPA. The plan is further supported with guidance and assistance from Ohio State University, Ohio Watershed Network and Ohio Department of Natural Resources, Division of Soil and Water Resources. The plan includes the following elements; building public support, defining water quality problems, setting water quality goals and developing solutions, and planning for the implementation of the plan.

The Upper Big Walnut Creek Watershed Action Plan includes:

- A comprehensive inventory of all known information (published and unpublished) pertaining to the water resources, geology, soil resources, biological features, agricultural resources, and cultural resources in the watershed.
- A thorough analysis of the biological, physical, and chemical properties for each of the eight subwatersheds.
- Problem statements, goals, objectives, and action items for each subwatershed.
- A plan for implementation of water quality best management practices in order to achieve water quality goals.
- A description of the evaluation process and procedures for updating the Upper Big Walnut Creek Watershed Action Plan.
- An information and education component to explain the purpose and goals of the watershed partnership and watershed action plan to the general public.

3.0 Watershed Inventory

This section provides a watershed inventory with details about the geology, glacial history, topography, soils, biological features, ecoregions, septic systems, rare, threatened and endangered species, invasive non-native species, water resources, land use, cultural resources,

These inventories help identify sensitive areas that influence the water resource. Information in this section can also help in understanding the role each natural feature plays in influencing the water resource and helps to determine the causes, sources and impacts of pollutants.

Geology

Although bedrock geology plays a vital role in determining the quality of ground water, it can also influence the quality of surface waters within a watershed. Bedrock geology can influence riffle patterns, wildlife habitat, flora, erodibility of streams, and oftentimes controls the topography and stream gradient.

The Upper Big Walnut Creek (UBWC) watershed straddles the Mississippian and Devonian geologic systems (map 3-1). This system is estimated to be 360-320 million years old. Bedrock series within this system include Bedford Shales, Berea Sandstone, Sunbury Shales, and the Cuyahoga formation.

The Devonian System (408-360 MYA) includes the Olentangy shale, Ohio hard carbonaceous shale, and clay shale. The Devonian System dominates the western region of the watershed. The bedrock underlying the Big Walnut Creek watershed is almost completely covered by glacial till except for outcrops where streams have eroded through the till. The last glacial advancement was about 23,000 years ago during the Wisconsin glaciations period.

Glacial History

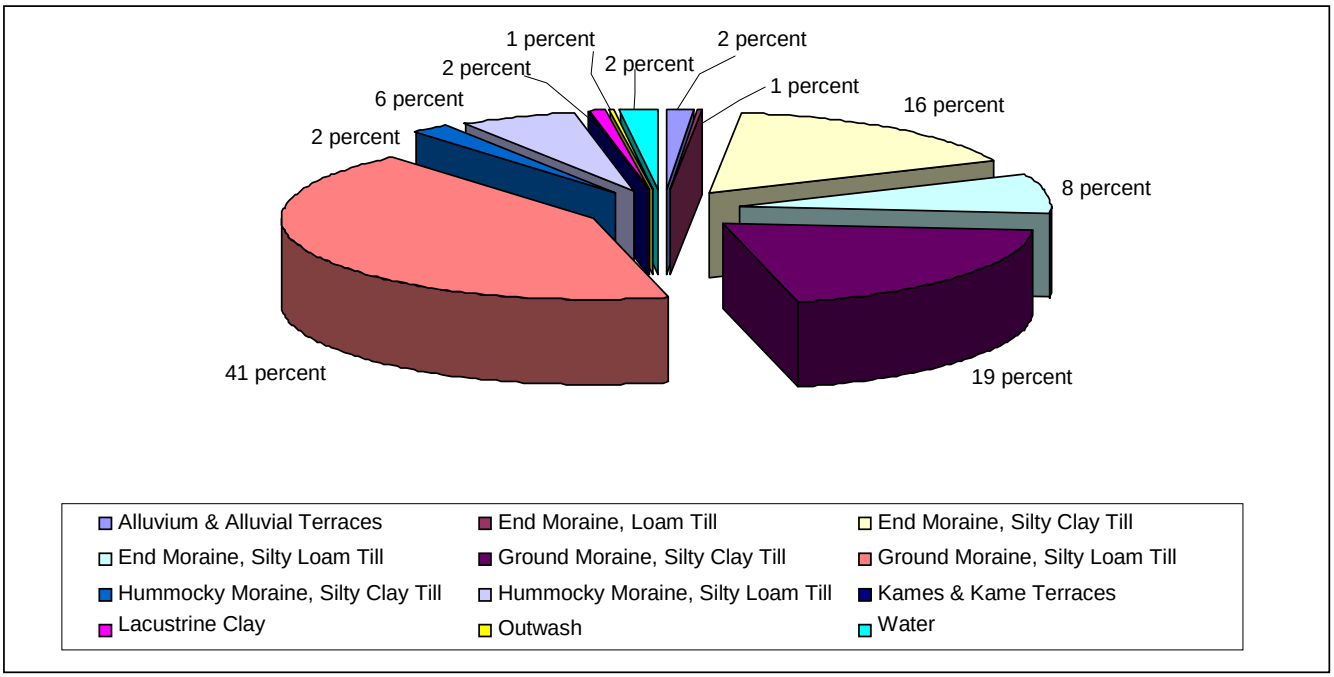
The glacial activity within the UBWC watershed had a profound influence on the soil types, land forms, and stream substrates. There were two periods of glacial activity which influenced the UBWC study area: the Wisonsinan (14,000-24,000 years ago) and the Illinoisan (130,000-300,000 years ago) glacier time period.

The Illinoisan glacier was the third of four major glaciers of the Pleistocene era. It has been estimated that the Illinoisan glacier began its decent some 300,000 years ago. This glacier advanced farther south than the more recent Wisconsinan glacier.

Around 70,000 years ago, ice began to build in northern Canada and slowly advance southward. The Wisconsinan glacier, the last major glaciation in Ohio, reached Ohio some 24,000 years ago and it reached its southern most extent 18,000 years ago. By this time the glacier covered nearly two-thirds of Ohio. The glacier began its retreat as the weather warmed and left Ohio about 14,000 years ago. Most of the landscapes in the glaciated portions of Ohio owe their formation to the Wisconsian glacier. Common landscape formations which were a result of the Wisconsian glacial activity include: thick deposits of till, ground moraines, sand and gravel outwash, and recessional moraines. (Ohio History Central, 2005).

End and ground moraines dominate the glacial features within the study area (map 3-2). The Powell Moraine (silty clay loam) enters the watershed to the west of Sunbury and follows the Big Walnut Creek north into Morrow County and divides the UBWC watershed from the Alum Creek watershed. Figure 3-1 illustrates the percentage of watershed acreage for each of the glacial features occurring within the UBWC watershed.

Figure 3-1. Percentage of Glacial Features in the Upper Big Walnut Creek Watershed



Topography

Topography is the study and mapping of land surfaces, including relief (relative positions and elevations) and the position of natural and constructed features (ESRI Dictionary). Topographic features, such as contours and elevations, probably play a role in understanding the mechanisms of water table interception within channelized drainage systems, particularly those channels excavated in lower, flatter terrain. Topographic features are also a determining factor when installing drainage water management structures for water quality. Generally, watershed areas should have less than 0.5 percent slope for control structures to manage as many acres as possible (Purdue Extension WQ-44). Topographic features also have a major impact on erosion and sedimentation. Soil loss equations, such as the Revised Universal Soil Loss Equation incorporate slope length and slope steepness in the formula.

The total relief for the watershed is 579 feet with an elevation range from 1,419 in Knox County to 841 at Hoover Reservoir. The northern reaches of the watershed in Morrow County and the eastern reaches around Knox County exhibit the most topographic relief in the watershed, whereas the southeastern portion of the watershed are relatively flat. The Headwaters subwatershed displayed the highest gradients within the study area with an average fall of 31 feet per mile. This figure includes Hayes Ditch which has an average fall of 5.6 feet per mile. The

average gradient for all named streams and tributaries within the study area is 27 feet per mile. A digital elevation map (DEM) is included in this section (map 3-3). The elevation range and total relief for each subwatershed is shown in table 3-1. The Headwaters subwatershed displayed the greatest relief in elevation with close to 128 meters while the Prairie Run subwatershed displayed the lowest topographical relief with just over 61 meters.

Table 3-1. Highest and Lowest Elevation and Relief (in meters) by Subwatershed

Subwatershed	Highest Elevation	Lowest Elevation	Relief
Headwaters - 010	432.6	304.7	127.9
Culver Creek - 020	413.1	310.7	102.4
Perfect Creek - 030	367.7	293.3	74.4
Rattlesnake Creek - 040	363.3	296.1	67.2
Prairie Run - 050	328.1	266.7	61.4
Little Walnut - 060	358.1	271.1	87.0
Hoover Reservoir - 070	336.5	257.2	79.3
Duncan Run - 080	371.7	256.2	115.5
Entire Watershed	432.6	256.2	176.4

Soils

Land use practices are, in many ways, a direct result of the soil types occurring within a watershed. In general, five major soil associations occur within the UBWC watershed: Amanda-Centerburg, Bennington-Pewamo-Centerburg, Bennington-Cardington-Pewamo, Bennington-Centerburg-Pewamo, Centerburg-Bennington, and Cardington-Bennington-Pewamo associations (figure 3-2 and map 3-4).

A soil association is defined as broad areas that have a distinctive pattern of soils, relief, and drainage. Each association has a unique natural landscape. Typically, soil associations consist of one or more major soils and some minor soils or miscellaneous areas. The association is named for the major soils. The components of one association can occur in another association but in a different pattern (Soil Survey of Delaware County). For more detailed information about the soils in the UBWC watershed see the soil surveys of Delaware, Morrow, Knox, Licking, and Franklin Counties.

Amanda-Centerburg Association This association consists of gently sloping to moderately steep, well drained and moderately well drained soils formed in medium textured glacial till. This association occurs in about (3.5) 2 percent of the watershed and is in the undulating to hilly eastern portions on ground moraines and end moraines in Morrow and Knox counties.

Amanda soils are gently to moderately steep and are well drained. They are on knolls and ridges and on the side slopes along drainageways. Typically, the surface layer is silt loam. The subsoil is clay loam, loam, and silt loam. Permeability is moderately slow. The seasonal high water table is below depths of 48 of 40 inches. The potential for frost action is moderate or moderately low. The content of organic matter is moderate or moderately low. (Soil Survey of Morrow County).

Centerburg soils are gently and moderately sloping and are moderately well drained. They are on knolls and ridges and on hillslopes along drainageways. Typically, the surface layer is silt loam. The subsoil is clay loam and silt loam. Permeability is moderately slow. The seasonal high water table is between depths of 18 and 36 inches during extended wet periods. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Morrow County).

Bennington soils are silt loam soils derived from till material. They are somewhat poorly drained with a slope range of 0 to 4 percent. They are found on slight rises, flat areas, knolls, swell-and-swale topography, and backslopes. They have slow permeability and have a moderate water holding capacity.

Most areas are commonly used for row crop production of corn, soybeans and small grains. Pasture or woodland management is commonly found within the steeper sloped regions. Erosion, runoff and low organic content of the soil are the limitations to agricultural land use. The relatively low permeability of the soil, slope and wetness restrict building site development and absorption fields for septic tank systems (Soil Survey of Morrow County).

Bennington-Pewamo-Centerburg Association makes up about (57.6) 40 percent or (70,052) 49,318 acres of the UBWC watershed. This soil association occurs along the east side of Delaware County. The association consists of very deep, level to strongly sloping, moderately well drained to very poorly drained soils formed in glacial till.

Bennington soils are nearly level and gently sloping and are somewhat poorly drained. They are on slight rises, flat areas, knolls, areas of swell-and-swale topography, and backslopes. Typically, the surface layer is silt loam. The subsoil is silty clay loam, clay loam, silty clay or clay. Permeability is slow. Depth to the seasonal high water table is 0.5 to 1.0 foot. The potential for frost action is high. The content of organic matter is moderate. (Soil Survey of Delaware County).

Pewamo soils are level or nearly level and are very poorly drained. These soils are in depressions, flat areas, and drainageways. Typically, the surface layer is silty clay loam. The subsoil is silty clay loam and silty clay loam. Permeability is moderately slow. Depth to the water table is 1.0 foot above to 0.5 foot below the surface. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County).

Centerburg soils are gently and moderately sloping and are moderately well drained. They are on knolls and ridges and on side slopes along drainageways. Typically, the surface layer is silt loam The subsoil is clay loam and silt loam. Permeability is moderately slow. Depth to the water table is 1 to 2 feet. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County). (map 3-4).
This association is conducive to agricultural row crops; however, due to its low permeability and water retention, subsurface drainage systems are needed for row crop production (Soil Survey of Delaware County).

Bennington-Cardington-Pewamo Association makes up (14.7) 15 percent or 17,921 acres of the UBWC watershed and is found along the Little Walnut Creek. This association has very deep, level to strongly sloping soils formed in glacial till. The soils range from moderately well drained to very poorly drained and have a slope range of 0 to12 percent. This association is commonly found within the low rises, depression, and knoll areas within the study area.

Bennington soils are nearly level and gently sloping and are somewhat poorly drained. They are on slight rises, flat areas, knolls, areas of swell-and-swale topography, and backslopes. Typically, the surface layer is silt loam. The subsoil is silty clay loam, clay loam, silty clay or clay. Permeability is slow. Depth to the seasonal high water table is 0.5 to 1.0 foot. The potential for frost action is high. The content of organic matter is moderate. (Soil Survey of Delaware County).

Pewamo soils are level or nearly level and are very poorly drained. These soils are in depressions, flat areas, and drainageways. Typically, the surface layer is silty clay loam. The subsoil is silty clay loam and silty clay loam. Permeability is moderately slow. Depth to the water table is 1.0 foot above to 0.5 foot below the surface. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County).

Cardington soils are gently and moderately sloping and are moderately well drained. They are on summits, shoulders, and backslopes. Typically, the surface layer is silt loam. The subsoil is silty clay loam and clay loam. Permeability is slow. Depth to the water table is 1 to 2 feet. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County).

This association is conducive to agricultural row crops; however, due to its low permeability and water retention, subsurface drainage systems are needed for row crop production (Soil Survey of Delaware County).

Bennington-Centerburg-Pewamo Association makes up about (2.4) 10 percent or (2,891) 12,320 acres of the UBWC watershed. This soil association occurs along the east side of Big Walnut Creek in Delaware County. The association consists of very deep, level to strongly sloping, moderately well drained to very poorly drained soils formed in glacial till.

Bennington soils are nearly level and gently sloping and are somewhat poorly drained. They are on slight rises, flat areas, knolls, areas of swell-and-swale topography, and backslopes. Typically, the surface layer is silt loam. The subsoil is silty clay loam, clay loam, silty clay or clay. Permeability is slow. Depth to the seasonal high water table is 0.5 to 1.0 foot. The potential for frost action is high. The content of organic matter is moderate. (Soil Survey of Delaware County).

Centerburg soils are gently and moderately sloping and are moderately well drained. They are on knolls and ridges and on side slopes along drainageways. Typically, the surface layer is silt loam. The subsoil is clay loam and silt loam. Permeability is moderately slow. Depth to the water table is 1 to 2 feet. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County).

Pewamo soils are level or nearly level and are very poorly drained. These soils are in depressions, flat areas, and drainageways. Typically, the surface layer is silty clay loam. The subsoil is silty clay loam and silty clay loam. Permeability is moderately slow. Depth to the water table is 1.0 foot above to 0.5 foot below the surface. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County). This soil is considered very poorly drained with a slope range of 0-1 percent.
This association is conducive to agricultural row crops; however, due to its low permeability and water retention, subsurface drainage systems are needed for row crop production (Soil Survey of Delaware County).

Centerburg-Bennington Association is the second most common soil association representing 23,864 acres or (19.6) 18 percent of the watershed. This soil association occurs mostly in the northern region of the watershed in Morrow County. The association consists of nearly level to moderately sloping, moderately well drained and somewhat poorly drained soils formed in medium textured glacial till.

These soils generally are in gently undulating to gently rolling areas on ground moraines and end moraines. In some areas they are on low knolls and ridges that have drainageways and a few depressions. Most areas are transected by small streams.

Centerburg soils are gently and moderately sloping and are moderately well drained. They are on knolls and ridges and on side slopes along drainageways. Typically, the surface layer is silt loam The subsoil is clay loam and silt loam. Permeability is moderately slow. The seasonal high water table is between depths of 18 and 36 inches during extended wet periods. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Morrow County).

Bennington soils are nearly level and gently sloping and are somewhat poorly drained. They are on flats, low knolls, and ridges in the uplands. Typically, the surface layer is silt loam. The subsoil is silty clay loam and loam. Permeability is slow. The seasonal high water table is between depths of 12 and 30 inches during extended wet periods. The potential for frost action is high. The content of organic matter is moderate. (Soil Survey of Morrow County).

These soils are compatible for row crop agricultural production when well drained and protected from erosion activities. Low permeability, wetness, low strength and high potential for frost action limit these soils for building site development and septic tank absorption fields (Soil Survey of Morrow County).

Cardington-Bennington-Pewamo Association makes up about 15 percent of the watershed. This soil association occurs mainly along Little Walnut Creek in Delaware County. The association consists of very deep, level to strongly sloping, moderately well drained to very poorly drained soils formed in glacial till.

Cardington soils are gently and moderately sloping and are moderately well drained. They are on summits, shoulders, and backslopes. Typically, the surface layer is silt loam. The subsoil is silty clay loam and clay loam. Permeability is slow. Depth to the water table is 1 to 2 feet. The

potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County).

Bennington soils are nearly level and gently sloping and are somewhat poorly drained. They are on slight rises, flat areas, knolls, areas of swell-and-swale topography, and backslopes. Typically, the surface layer is silt loam. The subsoil is silty clay loam, clay loam, silty clay or clay. Permeability is slow. Depth to the seasonal high water table is 0.5 to 1.0 foot. The potential for frost action is high. The content of organic matter is moderate. (Soil Survey of Delaware County).

Pewamo soils are level or nearly level and are very poorly drained. These soils are in depressions, flat areas, and drainageways. Typically, the surface layer is silty clay loam. The subsoil is silty clay loam and silty clay loam. Permeability is moderately slow. Depth to the water table is 1.0 foot above to 0.5 foot below the surface. The potential for frost action is high. The content of organic matter is moderate or moderately low. (Soil Survey of Delaware County).

Hydrologic Soil Groups

The Soil Survey Geographic Database (SSURGO) was used to examine the hydrologic soil groups for the Upper Big Walnut Creek watershed. Hydrologic soil groups are employed in the computation of runoff (Soil Survey Manual). Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. If a soil is assigned to two hydrologic groups, the first letter is for drained areas and the second is for undrained areas (County Soil Survey Reports). A total of 86,556 acres or 71 percent of the watershed is in hydrologic soil group C. This group is defined as soils having a slow infiltration rate when thoroughly wet (table 3-2 and map 3-5). These consist chiefly of soils having a layer that impedes the downward movement of water or soils that have a moderately fine texture or fine texture. These soils have a slow rate of water transmission. Approximately 21,079 acres or 17 percent of the watershed is in hydrologic soil group C/D. Group D are soils having a very slow infiltration rate (high potential for surface runoff) when thoroughly wet. These consist chiefly of clayey soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission (County Soil Survey Reports).

Table 3-2. Hydrologic Soil Group Classification, Acres, and Percent for UBWC Watershed (SSURGO)

	Hydrologic Groups and Acres						
Subwatershed	A/D	B	B/D	C	C/D	D	Not Rated
Headwaters	9	1,222	1,079	29,105	2,123	1,512	167
Culver Creek	2	281	252	5,803	2,132	82	15
Perfect Creek		91	324	4,301	1,565	94	34
Rattlesnake Creek		293	583	10,015	3,533	131	11
Prairie Run		334	140	3,562	1,169	14	288
Little Walnut Creek		422	1,216	16,003	2,822	105	376
Hoover Reservoir		83	202	11,028	3,984	358	3,383

Duncan Run		46	216	6,738	3,752	118	121
Total WS Acres	11	2,772	4,012	86,555	21,080	2,414	4,395
Total WS Percent	0	2	3	71	17	2	5

The sub-basins of Duncan Run, Rattlesnake Creek and area surrounding Hoover Reservoir have the highest percentages of hydrologic soil group classed C and D (table 3-2). Each sub-basin has less than one percent of hydrologic soil group B, the remaining soils have low to very low infiltration rates. Both agricultural production management and rural communities' wastewater treatment via septic systems will require substantial attention. Poor maintenance of agricultural drainage and septic systems will be exasperated because of the widespread distribution of low permeability soil types throughout the watershed.

Map Unit Hydric Soil Rating

This rating provides an indication of the proportion of the map unit that meets criteria for hydric soils. The Duncan Run and Rattlesnake Creek subwatersheds had the highest percentage of all hydric soil map units within the study area with 14 percent. These subwatersheds would be suitable locations for future wetland habitat creation or enhancement projects. Table 3-3 and map 3-6 show the extent and percentages of hydric soils within the UBWC study area.

Table 3-3. Hydric Soil Ratings by Subwatershed in the UBWC Study Area

Sub -watershed	All Hydric	Not Hydric	Partially Hydric	Unknown
Headwaters	22	8	33,304	1,885
Culver Creek	33	8	8,205	322
Perfect Creek	453	22	5,680	254
Rattlesnake Creek	2,084	16	11,959	506
Prairie Run	0	0	5,005	500
Little Walnut Creek	0	0	18,462	2,484
Hoover Reservoir	0	0	13,850	5,189
Duncan Run	1,535	0	8,747	708
Whole WS	4,127	53	105,212	11,847
Whole WS Percent	3.4	0	86.8	9.8

Prime Farmland

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable acidity or alkalinity, an acceptable concentration of salt or sodium, and few or no rocks. Its soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either does not flood frequently during the growing season or is protected from flooding (NSSH).

Map 3-7 and table 3-4 show the extent of prime farmland in each subwatershed based on soil classifications. Based on currently available data, 61 percent of the watershed is considered prime farmland only if drained and 12.6 percent of the watershed is considered not prime farmland.

Table 3-4. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland

Sub -watershed	Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
Headwaters	14,311	15,000	43 percent	129	5,778
Culver Creek	1,367	6,760	79 percent	123	317
Perfect Creek	1,023	5,066	79 percent	66	254
Rattlesnake Creek	2,885	10,956	75 percent	209	508
Prairie Run	2,053	2,817	57 percent	n/a	635
Little Walnut Creek	6,389	11,903	65 percent	n/a	2,656
Hoover Reservoir	2,243	12,095	72 percent	n/a	4,700
Duncan Run	1,246	9,310	85 percent	38	395
Whole WS	31,519	73,908	61 percent	566	15,240

Septic Tank Absorption Fields

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. These ratings are based on national standards for home sewage septic systems and do not incorporate local standards set forth by local health departments or soil scientists. Based on the national standards, 116,845 acres or 96 percent of the watershed (map 3-8) is very limited for home sewage septic systems. Additional work is needed to localize the data analysis for septic system suitability.

Drainage Class

Soil drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. The Duncan Run subwatershed has the highest percentage of somewhat poorly drained to very poorly drained soils in the study area at 84 percent. The Headwaters subwatershed has the highest percentage of moderately well drained acreage at 51 percent. Table 3-5 and map 3-9 lists the acreage for each soil drainage class by subwatershed.

Table 3-5. Soil Drainage Class Acreage by Subwatershed for the UBWC Study Area

Sub -watershed	Well drained	Moderately well drained	Somewhat poorly drained	Poorly drained	Very poorly drained	Unknown
Headwaters	2,069	17,954	10,341	1,479	3,244	130
Culver Creek	153	1,637	4,295	33	2,435	15
Perfect Creek	113	1,197	3,083	46	1,937	34
Rattlesnake Creek	223	3,368	6,716	33	4,213	11
Prairie Run	168	2,232	1,496	0	1,322	288
Little Walnut Creek	839	7,826	7,759	0	4,143	376
Hoover Reservoir	973	2,588	7,611	153	4,331	3,383
Duncan Run	196	1,363	5,293	17	4,000	121
Whole WS	4,735	38,166	46,594	1,761	25,627	4,358

Biological Features

Historically, much of the UBWC study area was covered with beech forests (88 percent) with pockets of Oak-Sugar maple (4 percent) and Elm-Ash Swamp (8 percent) forests. Today, the majority, 71 percent, of the watershed is in agricultural production. Most of the forested areas, under 24 percent, that remain within the study area are found within the riparian corridor and on steeper slopes. Common hardwood species currently found in these areas are; oak, maple, hickory, ash, and black walnut species.

Ecoregions

The Upper Big Walnut Creek watershed straddles two ecoregions. The Loamy, High Lime Till Plains of the Erie Drift Plains Ecoregion and the Low Lime Drift Plain of the Eastern Cornbelt Plains Ecoregion. Ecoregions are defined as areas that have similar ecosystems along with the land use, vegetation, land surface features, and soil types. The purpose for establishing ecoregions is to help assess ambient biological, chemical, and physical criteria to aid agencies in the management, and monitoring of ecosystems and ecosystem components.

The Eastern Corn Belt Plain ecoregion dominates the southern and southwestern portion of the watershed while the Erie Drift Plain dominates the northern sections of the study area (map 3-10).

Eastern Corn Belt Plain (ECBP) is defined as a primarily a rolling terrain with end moraines. Glacial deposits are extensive in this ecoregion. Originally, maple-beech-birch forests were common within this ecoregion. Today, row crop production and livestock production dominates the landscape.

Erie Drift Plain (EDP) was once covered by maple-beech-birch forests. Now much of the area is in agricultural land use. This ecoregion has a more rolling landscape then the flatter Eastern Corn Belt Plains, which border the EDP region to the west in the UBWC watershed. The Erie Drift Plain is characterized by low rounded hills, scattered end moraines, kettles, and areas of wetlands.
The two sub-ecoregions are described by US EPA as the following (Simon, 1997):

55b.The **Loamy, High Lime Till Plain** ecoregion contains soils that developed from loamy, limy, glacial deposits of Wisconsinan age; these soils typically have better natural drainage than those of Ecoregion 55a and have more natural fertility than those of Ecoregion 55d. Beech forests, oak-sugar maple forests, and elm-ash swamp forests grew on the nearly level terrain; today, corn, soybean, and livestock production is widespread.

61c. The **Low Lime Drift Plain** ecoregion has a rolling landscape composed of low rounded hills with scattered end moraines and kettles; its terrain is distinct from the unglaciated, wooded, hilly country of Ecoregion 70 and its soils are usually less naturally fertile than the high lime till plains of Ecoregion 55. Urban-industrial activity as well as dairy, livestock, corn, and soybean farming are common; many ridges and lowlands are wooded. The growing season is shorter than that of Ecoregion 61a, and progressively decreases away from Lake Erie.

Rare, Threatened and Endangered Species

A list of threatened and endangered species provided by ODNR Division of Natural Areas and Preserves is included below. There are other threatened, endangered, and species of concern found within the five counties that make up the UBWC study area, but the list below is specific to the study area. The US Fish and Wildlife has listed the following rare, threatened, and endangered species for the five counties within the UBWC study area (table 3-7).

Table 3-6. Rare, Threatened, and Endangered Species Found in UBWC Study Area

Common Name	Scientific Name	Year Recorded	State Status
Butternut	*Juglans cinerea*	2000	Potentially Threatened
Gattinger's-foxglove	*Agalinis gattingeri*	2001	Threatened
Prairie False Indigo	*Baptisia lactea*	2001	Potentially Threatened
Sora	*Porzana carolina*	1985	Species of Special Concern
Virginia Rail	*Rallus limicola*	1985	Species of Special Concern

Table 3-7. US Fish and Wildlife Threatened and Endangered Species List by County for UBWC Study Area

Common Name	Scientific Name	County	State Status
Indian bat	*Myotis sodalist*	All	Endangered
Clubshell	*Pleurobema clava*	Delaware	Endangered
Rayed bean	*Villosa fabalis*	Delaware	Critical Habitat
American bald eagle	*Haliaeetus leucocephalus*	Delaware, Knox, Licking	Species of Special Concern
Sunffbox	*Epioblasma triquetra*	Delaware	Species of Special Concern
Eastern massasauga rattlesnake	*Sistrurus catenatus catenatus*	Licking	Critical Habitat

Scioto madtom	*Noturus trautmani*	Franklin	Endangered
Northern riffleshell	*Epioblasma torulosa*	Franklin	Endangered

Invasive Non-native Species

Several invasive plant species are present in the Upper Big Walnut Creek Watershed. An invasive species is an organism (plant, animal, insect) that is spread from human settings (gardens, fishing ponds, and agriculture) into the environment. Once an invasive species establishes itself in an environment, they grow and reproduce at a rate in which most native organisms cannot compete with.

Most invasive species are non-native species. A non-native or non-indigenous species is typically defined as a species that has emerged after European settlement and is introduced into an area by humans.

Invasive species can significantly alter a native ecosystem. As mentioned before, most invasive species are non-native. When a species is transplanted from one region to another, the bio-control methods that help keep growth and reproduction in check are left behind. Bio-control methods are simply the organisms that prey upon or compete with the species in question. The lack of bio-control species allows non-native species to spend more energy on growth and reproduction rather than spending energy on defense mechanisms.

Invasive species can decrease the overall biodiversity of the region it has invaded. The biodiversity of an area is defined as the variety of life found within a particular area. Invasive species impact biodiversity by out-competing the native species found within the region. This may lead to a decrease in wildlife, aesthetic beauty, or overall health of the ecosystem.
The ODNR Division of Natural Areas and Preserves lists the non-native invasive plant species found in the state of Ohio. They have also listed targeted species that are found to be a special concern due to the severity of invasiveness and overall state distribution. Of these invasive plant species, seven are found within the UBWC study area (table 3-8).

Table 3-8. Invasive Species of Special Concern Found Within UBWC Study Area

Common Name	Scientific Name
Multiflora rose	*Rosa multiflora*
Common reed grass	*Phragmites australis*
Reed-canary grass	*Phalaris arundinacea*
Purple loostrife	*Lythrum salicaria*
Morrow honeysuckle	*Lonicera morrowii*
Garlic Mustard	*Alliaria petiolata*
Autumn olive	*Elaeagnus umbellata*

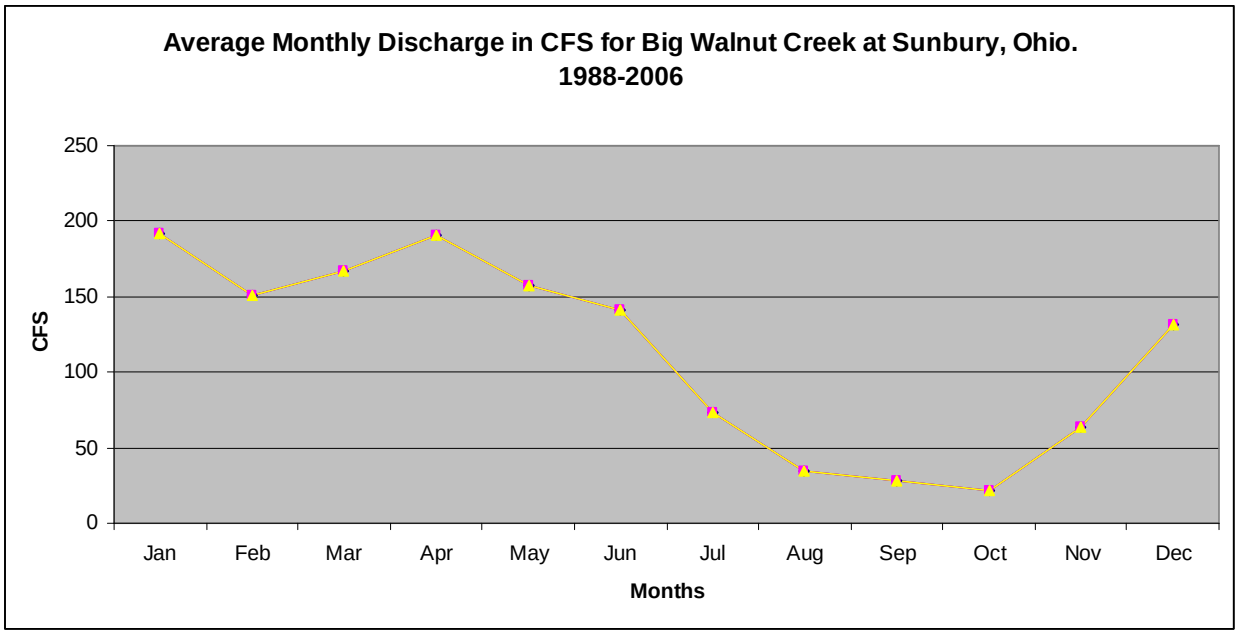
Water Resources

Climate and Precipitation

This watershed falls within the temperate middle-west North American region which generally has well-defined seasons. The average temperature for the UBWC study area throughout the year is 50º F (County Soil Surveys). The watershed receives an average of 40 inches of rain per year with a monthly average of 3.3 inches (OSUE, 1995). The wettest months are typically June and July while the driest month on average is February (OSUE, 1995). Precipitation during the growing season (April-July) average 17 inches. This is important in this study area as most pesticides and fertilizers are washed into surface waters during this time period.

Data collected from the USGS gauging station (station number 03228300) located on the Big Walnut Creek at Sunbury, Ohio shows the average monthly stream flow velocity from 1988-2006 (figure 3-2). The largest stream flows occur in January while the lowest occur in October.

Figure 3-2.



Source: USGS station 03228300

Climate Change and Water Resources

Climate change and climate variability present a challenge to ecologically, economically, and socially sustainable land management. Drought, floods, and temperature fluctuations due to climate change can directly affect agricultural operations through damage to crops and livestock. Indirect effects of climate change include higher soil erosion rates, more invasive species, and changes in soil and vegetative relationships. The consequences of global warming will not be spread evenly across the planet and the challenges of coping with changes will be regionally unique (USDA-NRCS).

All regions of the world show an overall net negative impact of climate change on water resources and freshwater ecosystems. Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources. The beneficial impacts of increased annual runoff in other areas are likely to be tempered in some areas by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality and flood risks (IPCC 2007).
The future effects of climate change on water resources in the U.S. and other parts of the world will depend on trends in both climatic and non-climatic factors. Evaluating these impacts is challenging because water availability, quality and streamflow are sensitive to changes in temperature and precipitation. Other important factors include increased demand for water caused by population growth, changes in the economy, development of new technologies, changes in watershed characteristics and water management decisions.

In addition to the typical impacts on water management, climate change introduces an additional element of uncertainty about future water resource management. Water resources in the United States are heavily managed and supplies are scarce in some regions of the country. Strategies have been developed and continue to evolve to address these issues. Implementation of adaptation measures, such as water conservation, use of markets to allocate water, and the application of appropriate management practices will have an important role to play in determining the impacts of climate change on water resources.

Generally speaking, in areas where precipitation increases sufficiently, net water supplies may not be affected or they may even increase. In other areas where precipitation remains the same or decreases, net water supplies would decrease. Where water supplies decrease, there is also likely to be an increase in demand, which could be particularly significant for agriculture (the largest consumer of water) and also for municipal, industrial and other uses (USEPA).
Higher water temperatures and changes in the timing, intensity, and duration of precipitation can affect water quality. Higher temperatures reduce dissolved oxygen levels, which can have an effect on aquatic life. Where streamflow and lake levels fall, there will be less dilution of pollutants; however, increased frequency and intensity of rainfall will produce more pollution and sedimentation due to runoff.

Flood magnitudes and frequencies will very likely increase in most regions — mainly a result of increased precipitation intensity and variability — and increasing temperatures are expected to intensify the climate's hydrologic cycle and melt snowpacks more rapidly (IPCC, 2007).
Flooding can affect water quality, as large volumes of water can transport contaminants into water bodies and also overload storm and wastewater systems.
Higher temperatures, particularly in the summer, earlier snowmelt, and potential decreases in summer precipitation could increase risk of drought. The frequency and intensity of floods and droughts could increase, even in the same areas (USEPA).

A July 2008 Center for Integrative Environmental Research, University of Maryland report titled *Economic Impacts of Climate Change on Ohio,* projects "climate change will affect our water, energy, transportation, and public health systems, as well as state economies as climate change impact a wide range of important economic sectors from agriculture to manufacturing to

tourism." Since 1895 the average annual temperature in Columbus, Ohio has increased by 0.3° F (.2 ° C) (EPA 1998).

According to the Union of Concerned Scientists, a science-based nonprofit working for a healthy environment and a safer world, a 5-7°F rise in winter and a 7-9°F rise in summer temperatures by the end of the century is projected [for Ohio]. Although average annual precipitation may not change much, an overall drier climate is expected because rainfall cannot compensate for the increase in evaporation resulting from greater temperatures. Seasonally, winter precipitation is expected to increase by 15-20% and summer precipitation is expected to decrease by 10-15%. Thus Ohio may see drier soils and more droughts. Extreme heat will be more common, and the frequency of heavy rainstorms will increase.

Availability of safe freshwater supplies will become an increasing concern with climate change. Although there will likely be more heavy rainfall events, this precipitation is not expected to sustain surface water supplies. With warmer average temperatures and increased evaporation, groundwater will be used more heavily and surface water supplies will become scarcer and more contaminated. Approximately 95% of public water systems in Ohio use ground water, at least in part, as their source of drinking water (Ground Water Protection Council 1999). Such a scenario, in which heavy rains are followed by drought that strains public drinking water supplies, already occurred in Ohio during the droughts of 1988 and 1991 (Rogers 1992) (Center for Health and the Global Environment, Harvard Medical School).

Plan for the impacts of climate change - Although there are many steps we can take to reduce the severity of climate change, some changes are already underway and will continue for decades or more. Therefore, society must begin planning and preparing to manage future impacts that cannot be avoided. Such actions include: protecting wetlands—which provide key flood control services and improve local water quality; examining adaption options in the local fisheries, agricultural and forestry practices (Union of Concerned Scientists, Climate Change in Ohio).

Surface Water

The Big Walnut Creek (BWC) rises in southern Morrow County some 1.25 miles southeast of Mt. Gilead. From here the BWC flows south through agricultural areas with numerous named and unnamed tributaries entering from the east. The first 10 miles of the main branch have been channelized at one time. Some areas are recovering and some are still being maintained for optimum water movement (figure 3-4). Big Walnut Creek continues to flow south into Delaware County where the first major tributary, Culver Creek enters from the east. This ends the Headwaters subwatershed of the study area which contains approximately 68 named river miles and 35,230 acres in Morrow and Delaware Counties. Culver creek starts up in Knox County and flows west towards Big Walnut Creek. The Culver Creek subwatershed contains 11 named river miles in an area of 8,567 acres in Knox and Delaware Counties. The main stem of Big Walnut Creek continues to flow south through agricultural areas towards Sunbury where it enters the Hoover Reservoir just below Galena, Ohio. Perfect Creek and Rattlesnake Creek join the Big Walnut Creek, prior to Hoover Reservoir, from the east. The Perfect Creek subwatershed has approximately 14 miles of named river miles in an area of 6,410 acres. The Rattlesnake Creek subwatershed is the fourth largest subwatershed in the study area with 14,565 acres and has the third most named stream miles with 27. The Prairie Run subwatershed, with an area of 5,506

acres and 8 miles of named streams, contains just over 3.5 miles of the main stem of the Big Walnut before it enters Hoover Reservoir.

Figure 3-3. Upper Big Walnut Creek begins as a ditch in Morrow County

The Little Walnut Creek subwatershed is the second largest in land area with 20,946 acres and over 28 miles of named streams. The third largest subwatershed encompasses the land that drains into the Hoover Reservoir between Little Walnut Creek and the Hoover Reservoir Dam. This subwatershed contains 19,039 acres with just over 7 miles of named streams. Most of the streams in this subwatershed are unnamed tributaries which drain directly into Hoover Reservoir. Finally, the Duncan Run subwatershed is the southern most watershed in the study area. Duncan Run rises in Licking County and flows west into Delaware County where it enters the Hoover Reservoir. This subwatershed has and area of 10,990 acres and over 13 miles of named streams. Table 3-9 lists each subwatershed and the area in square miles and acres.

Table 3-9. The 14-digit HUC Subwatersheds in the UBWC Study Area

Subwatershed name	14-digit HUC #(05060001130-***)	Square Miles	Acres	Counties
Headwaters (Headwaters to above Culver Creek)	05060001130-010	55.09	35,230	Delaware, Morrow, Knox
2 – Culver Creek	05060001130-020	13.39	8,567	Delaware, Knox
Perfect Creek	05060001130-030	10.02	6,410	Delaware, Knox, Licking
Rattlesnake Creek	05060001130-040	22.76	14,565	Delaware, Licking
Prairie Run	05060001130-050	8.60	5,506	Delaware
Little Walnut Creek	05060001130-060	32.73	20,946	Delaware, Morrow

Big Walnut Creek below Little Walnut Creek to above Hoover Reservoir	05060001130-070	29.75	19,039	Delaware, Franklin
Duncan Run	05060001130-080	17.17	10,990	Delaware, Licking

Use Designations
All of the streams within the UBWC study area have a Warm Water Habitat (WWH) aquatic life use designation. This designation is assigned to surface waters that are capable of maintaining a balanced and adaptive assemblage of warmwater aquatic organisms. The five ecoregions found in Ohio are used to create the biological criteria for the WWH aquatic life use designation. According to the Total Maximum Daily Load Report (OEPA,2005) there are 28.15 river miles in the study area that are not attaining their WWH use status and 4.85 river miles in partial attainment.

The recreational use for the Big Walnut and tributaries is Primary Contact Recreation (PCR). The exception is Prairie Run which is designated a Secondary Contact Recreation waterway. Primary Contact Recreational waters are defined as those which are capable of supporting canoeing and swimming activities. Currently, portions of Reynolds Run, Culver Creek, and Mill Creek are not attaining this use designation due to average and peak levels of bacteria (OEPA, 2005). Secondary Contact Recreational waterways lack sufficient depth for canoeing and swimming activities.

Sinuosity
Sinuosity is the ratio of total river length between two points divided by the straight distance between the two points. The higher the ratio the more sinuous the stream is. A stream with a higher sinuosity ratio has greater surface area and provides greater opportunity for water and sediment reactions (Mackie, 2004). A stream with a sinuosity ratio of 1-1.5 is referred to as sinuous where a stream with a ratio of greater than 1.5 is referred to as meandering. The UBWC study area had an average sinuosity of 1.24. Perfect Creek and Rattlesnake Creek subwatersheds had the highest sinuosity ratios with 1.30 and 1.31 respectively. While Prairie Run subwatershed had the lowest ratio with 1.10.

Table 3-10. Average Sinuosity by Subwatershed

Subwatershed	Average Sinuosity
Headwaters-010	**1.27**
Culver Creek-020	**1.26**
Perfect Creek-030	**1.30**
Rattlesnake Creek-040	**1.31**
Prairie Run-050	**1.10**
Little Walnut Creek- 060	**1.20**
Hoover Area-070	**1.22**
Duncan Run-080	**1.20**
Whole Watershed	**1.24**

Lakes, Reservoirs, Ponds
All lakes, reservoirs, and ponds in the watershed are man-made. There are numerous smaller private ponds throughout the watershed. The largest man-made impoundment in the study area is the Hoover Reservoir. This reservoir is the main source of drinking water for the City of Columbus and services more than 500,000 residents. The reservoir consists of approximately 3,800 acres of open water and holds close to 21 billion gallons of water. The reservoir has a residence time (also known as removal time) of about six months which can be problematic for the build up of nonpoint source pollutants. The City of Columbus owns approximately 1,200 acres of land adjacent to the reservoir. The buffered land is considerably smaller when compared to other source water reservoirs in Delaware County and the area adjacent to this land is rapidly developing.

Wetland Habitat
Most of the wetlands which existed within the watershed project area have been drained for agricultural purposes. Recently, wetland habitats are being threatened by increased residential, and urban development in the watershed. Approximately, 27,387 or 22 percent of watershed acres are considered to be poorly drained to very poorly drained. The Ohio Wetland Inventory has identified 4,870 acres of wetland habitat in the UBWC study area (table 3-11, map 3-11). This figure is well below the combined acreage of total hydric (4,127) and partially hydric (105,212) soils identified by SSURGO. Additionally, the 1999-2003 OEPA-DSW land cover data set classified 79 acres of woody wetland in the entire UBWC study area.

Loss of wetland habitat can be devastating to the ecology of a watershed. Wetland habitat acts as biological filters within watersheds and can store excess runoff from larger storm events. These characteristics can prevent downstream flooding and help to filter pollutants from the surface waters. Numerous plant and animal species utilize wetland habitats. According to the Ohio Department of Natural Resources, wetland loss is the second leading cause of wildlife endangerment in Ohio.

Table 3-11. Ohio Wetland Inventory Acres

Subwatershed	Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
Headwaters-010	**29.12**	**53.35**	**55.90**	**6.8**	**546.92**
Culver Creek-020	**9.37**	**30.92**	**66.84**	**2.63**	**544.20**
Perfect Creek-030	**13.76**	**15.65**	**25.09**	**3.13**	**267.26**
Rattlesnake Creek-040	**36.77**	**24.20**	**21.93**	**2.02**	**519.77**
Prairie Run-050	**4.28**	**31.61**	**27.44**	**6.31**	**216.70**
Little Walnut Creek-060	**25.07**	**56.63**	**44.42**	**2.04**	**807.52**
Hoover Reservoir-070	**21.37**	**123.27**	**61.34**	**3.84**	**769.19**
Duncan Run-080	**19.31**	**25.85**	**19.17**	**11.52**	**473.43**
Whole WS	**159.08**	**361.53**	**322.69**	**38.37**	**4,147.39**

Ground Water
Ground water is an important drinking water resource in the watershed as many rural watershed residents utilize ground water wells for their primary water source. In general, the watershed has lower flow rates than surrounding areas with most of the area having a flow rate of less than 5 gallons per minute (ODNR Division of Water). The eastern portion of the watershed can yield

15-20 gallons per minute (gpm) where sandstone aquifers are present. The northern region of the watershed, underlain with shale and sandstone bedrock, can produce an average of 25 gpm.

A ground water pollution potential mapping program for Ohio was initiated in 1986 under the direction of the Ohio Department of Natural Resources, Division of Water. The DRASTIC mapping system, developed by Aller, et al., 1987, was chosen because it allows the pollution potential of an aquifer to be evaluated systematically using existing information. The DRASTIC method is used by Ohio EPA to evaluate ground water sensitivity to contamination (ODNR-DSWR). This system uses a ranking scheme to evaluate and prioritize ground water sources. Data is available for Delaware and Licking Counties, but currently unavailable for Knox and Morrow Counties. Water tables are generally shallow throughout the watershed with 47 percent of the area having a ground water table depth between 15-22 feet. Within the watershed the following townships had the greatest aerial extent of ground water pollution potential: Berkshire, Trenton, Harlem, and Genoa in Delaware County. These areas had scores ranges from 100-139 with system scores of 200 being of great concern and less than 79 of little concern. There are no present areas within the watershed that have a Drinking Water Source Protection Area for Public Water Systems Using Ground Water designation. However, the area does fall under this designation for surface waters.

Drainage

The Upper Big Walnut Creek watershed's drainage network is made up by a series of natural and man-made channels and subsurface drainage mains or conduits. Agricultural drainage improvements can be made to the soil surface, the subsurface, or a combination of both. Surface drainage is designed to remove standing water from the soil surface through land leveling and smoothing or constructing shallow ditches or grassed waterways. Subsurface drainage is designed to remove excess water from the soil profile through a series of drainage pipes (tile or tubing). Surface and subsurface drainage improvements require suitable outlets to remove excess water.

Historically, the main reason for drainage on agricultural land has been to enhance crop production. Drainage removes excess water from the soil and helps create a well-aerated root zone that enhances plant uptake of nutrients. Drainage on wet agricultural soil allows timely field operations, and helps plant growth to begin early, continue vigorously, and achieve improved levels of productivity.

It is estimated that approximately 68 percent of the total cropland acres in the Upper Big Walnut Creek watershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table.

In the Upper Big Walnut Creek watershed several villages, unincorporated communities, and rural homeowners also rely on a rural drainage network to prevent flooding, wet backyards, and wet basements. In some watershed areas the rural drainage network is facing some major challenges that include the following:

1. The useful life of many drainage systems has been exceeded,
2. The increasing number of rural landowners often do not understand or want to pay for drainage improvement projects,

3. Funding for adequately staffing rural drainage improvement projects at the county and state level has been redirected to other priorities, and
4. Agency regulation and public scrutiny are often increasing the time, effort, and cost of completing a drainage improvement project.

Drainage systems were originally designed for the efficient and economical removal of excess water; they were not installed as water quality management tools. As a result, drainage systems also efficiently deliver sediment, nutrients, and other pollutants downstream. The export of nutrients downstream can have drastic impacts. The largest example currently being investigated is the hypoxic zone in the Gulf of Mexico. The result is a large area in the Gulf of Mexico that is essentially devoid of aquatic life. The cause of this hypoxic zone is thought to be the result of increased runoff of nitrogen fertilizers from the Mississippi River Basin (MRB). The Upper Big Walnut Creek Mississippi River Basin Initiative-Cooperative Conservation Partnership Initiative recognizes the water quality impacts on the MRB and the Gulf of Mexico and implements practices to avoid, control, and trap nutrients that could lead to hypoxic conditions (this section adapted, in part, from Draft Ohio Drainage Manual 2009).

Drainage maintenance projects in the Upper Big Walnut Creek watershed that are undertaken by County Engineers and Soil and Water Conservation Districts follow all state laws, rules, and guides for best management practices. Drainage projects seek to assure minimal environmental disturbance while providing efficient and economical removal of excess water. Typically, a trapezoidal design provides the best all-around open channel system for maintaining existing agricultural and urban drainage systems. Maintenance activities consist of annual inspections, minor to major structural repairs, replacements when needed, erosion control, logjam/obstruction removal, and spraying of brush and cattails. Drainage easements are areas of property reserved for maintenance activities and are subject to specified rules. Easements are determined by the County Engineer, approved by the County Commissioners, and are a part of property deeds or plats. Drainage construction and maintenance projects undertaken on private property by private landowners or their contractors commonly do not utilize Best Management Practices and may cause environmental problems. Information contained in various Ohio drainage reports, manuals, and laws can help private landowners understand the nature of rural drainage systems, what good they do, how they should be maintained, and the consequences of inadequate design, construction and maintenance. These Ohio drainage resources also offer newer, alternative drainageway designs to aide in improving degraded habitats, nutrient processing and wildlife biodiversity goals, yet still provide drainage of runoff water.

A constructed trapezoidal channel is typically excavated in flat landscapes to facilitate drainage. The channel serves as an outlet for surface runoff and subsurface drains where natural drainage is inadequate for the proposed land use. They are most applicable at the upper end of small watersheds of about 3 square miles, where the required depth for subsurface drain outlets must be maintained and/or where soils and existing grades will not support natural stream function. The major advantage of this type of construction is low material and construction costs and a minimal area required for construction and implementation. However, trapezoidal channels generally are not considered supportive of ecological services for water quality. The draft Ohio Drainage Manual includes an OEPA proposal to create a new aquatic life use sub-category,

"General Aquatic Life", which would apply by rule to drainageways under 2000 acres of drainage area (Rural Drainage Systems 2008).

Trapezoidal channels have been used for decades as an economical and efficient way to dispose of excess water. These channels have historically been built to address drainage needs where natural drainage proved insufficient for the proposed land use. When considering the construction and installation of a trapezoidal channel, careful consideration must be given to the existing channel, and minimizing water pollution, and damage to fish and wildlife habitat. In design of the channel, the designer must consider site geology, required channel capacity, required cross section and channel grade, channel stability, appurtenant structures required, disposal of spoil, vegetation establishment, and erosion control during and after construction. Vegetation, where practical, is the most desirable lining for an artificial channel. It stabilizes the channel body, consolidates the soil mass of the bed, checks erosion on the channel surface, provides habitat and provides water quality benefits

Alternative constructed channel designs include:

- One-sided construction – provides some ecological benefit.
- Two-stage channel design – allows beneficial characteristics of the channel bed and low banks to be preserved, e.g. course substrate, pool and riffle bed form, low bank vegetation, meander pattern. A two-stage channel has the potential to create and maintain better habitat than a single-stage, trapezoidal channel. The narrow, deep nested channel provides sufficient water depth for aquatic species during periods of low flow. Grass on the benches can provide quality cover and shade over the nested channel. Substrate in the nested channel is sorted, with fine sediment conveyed or deposited on the benches and course material forming the bed.
- Over-wide channel – develop self-formed soil benches which are rich and active. Their development is a complex physical and biological process; driven by annual layers of vegetation and deposition. This may be critical for pollutant assimilation and riparian quality and an important distinction of this practice.
- Natural channel – has stated goal of the establishment of biological integrity. Another, perhaps more appropriate goal is channel form that will perform ecological services.

Ohio's drainage laws have been updated many times as the state has grown and developed. Drainage systems that were originally built to enhance agricultural production have also made former wetlands suitable for communities, home sites and industrial development. Today, municipalities manage water with their own set of drainage laws, but most rural drainage projects involving multiple landowners are organized under Ohio's Petition Ditch Law (Ohio Revised Code 6131) or Conservation Works of Improvement (Ohio Revised Code 1515). While there are important differences in how these two legal processes work, both fund projects with assessments on affected landowners and require that the financial benefits of a project exceed its cost.

Comprehensive information pertaining to agricultural, residential and urban drainage in the Upper Big Walnut Creek watershed is available through various agencies and institutions including the Ohio Department of Natural Resources, Division of Soil and Water Resources, Ohio State University Extension, Ohio EPA, County Engineers, County Soil and Water

Conservation Districts, U.S. Army Corps of Engineers, and U.S. EPA. Laws, rules, and guides and other information relating to drainage construction and maintenance projects are available in Ohio's Petition Ditch Law (Ohio Revised Code 6131), Conservation Works of Improvement (Ohio Revised Code 1515); the 2009 draft Ohio Drainage Manual; Rural Drainage Systems (2008 report); Drainage Survey Executive Summary (2005 ODNR-DSWC Rural Drainage Survey); and locally produced rules and codes, and other informational materials.

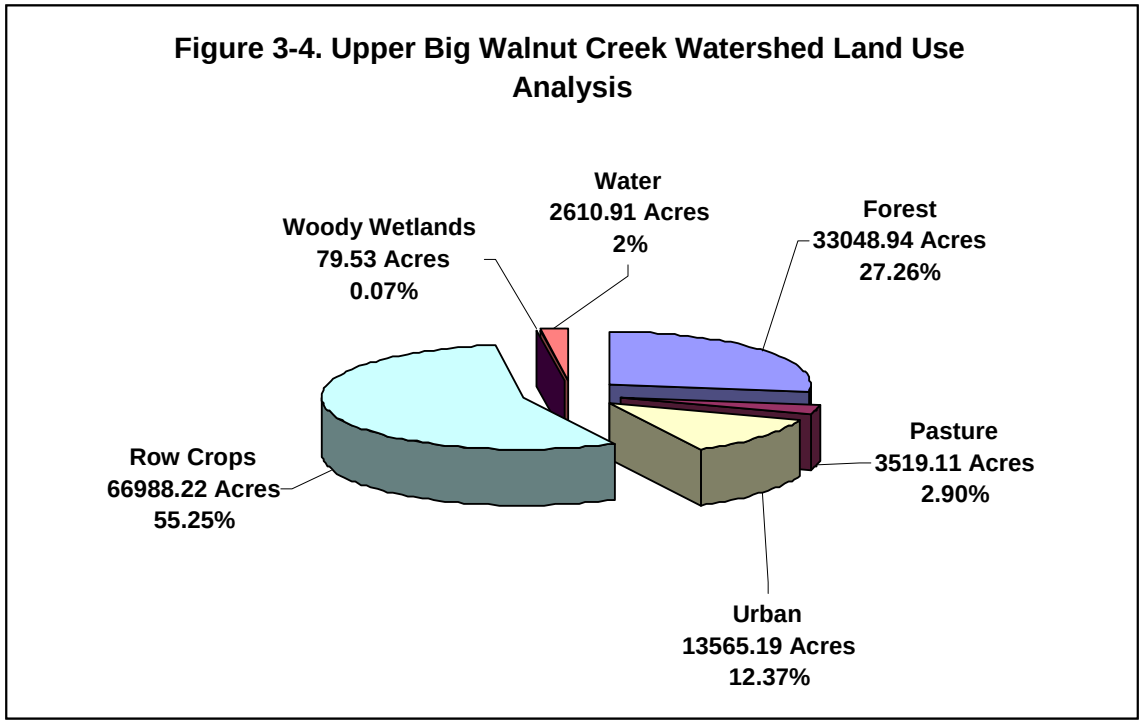
Land Use

Land use activities within a watershed can have a direct impact on the quality of water resources and drives the overall health of the watershed. The 1999-2003 OEPA-DSW land cover dataset was used to analyze the land cover data. Table 3-12 includes a general summary of land cover data from the 1994 Landsat by subwatershed and for the whole study area. The UBWC study area is a rural watershed with over 71 percent of the land use in agriculture activities the majority of which is in row crop production at 51 percent and the remaining 20 percent in pasture land. Forested areas comprise close to 24 percent of the land cover in the watershed with deciduous forest making up 99 percent of the forested land use category. Open water areas make up 2.15 percent of the watershed with the majority being Hoover Reservoir.

Table 3-12. Percentages of Land Cover Type from 1999-2003 OEPA-DSW

Subwatershed	Water	Urban	Forested	Row Crop	Pasture	Woody Wetlands
Headwaters-010	0 percent	8.23 percent	33.43 percent	56.49 percent	1.72 percent	.14 percent
Culver Creek-020	0 percent	11.11 percent	23.74 percent	59.24 percent	5.54 percent	.36 percent
Perfect Creek-030	0 percent	4.99 percent	18.16 percent	67.00 percent	9.86 percent	0 percent
Rattlesnake Creek-040	0 percent	10.34 percent	13.76 percent	71.64 percent	4.27 percent	0 percent
Prairie Run-050	0.97 percent	23.25 percent	23.03 percent	52.75 percent	0 percent	0 percent
Little Walnut Creek-060	0.04 percent	15.13 percent	30.43 percent	49.15 percent	5.25 percent	0 percent
Hoover Reservoir-070	12.86 percent	18.46 percent	34.54 percent	34.15 percent	0 percent	0 percent
Duncan Run-080	.92 percent	12.35 percent	16.91 percent	69.03 percent	.79 percent	0 percent
Entire WS	2.15 percent	12.37 percent	27.26 percent	55.25 percent	2.90 percent	0.07 percent

Figure 3-4 and map 3-12 illustrate the percentage and distribution of land use categories across the UBWC watershed. The following sections analyze each category for management purposes.



Urban

The Urban land use category is a combination of residential and commercial development lands within the study area. Although most of the watershed is dominated by agricultural land use, there has been an increase in urban development activities in the watershed. The Hoover Area, 070, subwatershed has the most urban acres with 3,514 which accounts for 18.5 percent of the subwatershed. The Perfect Creek subwatershed has the least amount of urban land cover with 320 acres which accounts for 5 percent of the subwatershed area. Although the Little Walnut Creek subwatershed only has 1,280 acres in urban land cover, they account for over 23 percent of the total watershed area making this the most urbanized subwatershed based on percentage. Subwatersheds 060 and 070 contain the greatest acreage of urban area and are both adjacent to the largest incorporated area in the watershed, Sunbury.

Table 3-13. Urban Land Use by Subwatershed

Subwatershed	Acres	Percent of subwatershed
Headwaters-010	2,896.77	8.23
Culver Creek-020	951.57	11.11
Perfect Creek-030	319.54	4.99
Rattlesnake Creek-040	1,505.39	10.34
Prairie Run-050	1,280.12	23.25
Little Walnut Creek-060	3,168.57	15.13
Hoover Area-070	3,513.87	18.46
Duncan Run-080	1,357.31	12.35

Delaware County is the fastest growing county in Ohio and 12th fastest in the United States (US Census, 2000). The majority of this growth is due to urban sprawl from Columbus in the southern portions of the county. The fastest growing townships within the study area are Genoa and Harlem Townships. These two townships are considered storm water communities and must apply for NPDES permits. As development continues to encroach upon the study area, there will be an increase in the amount of impervious cover. Impervious cover can lead to an increase in stormwater volume, nonpoint source pollution, and siltation within a watershed. Community stormwater plans, soil and erosion control ordinances and a watershed-wide education and outreach programs will need to be implemented to limit future development related impacts.

Forested

The forested areas comprise 28,865 acres or 27 percent of the UBWC study area. Deciduous forests dominate this land cover with over 99 percent of which is comprised of roughly 35 percent oak-hickory, 35 percent elm-ash-soft maple, and 30 percent beech-hard maple (Sykes, 1999). The headwaters subwatershed has the most forested acres with 11,772 or 33 percent of the subwatershed area. Rattlesnake Creek subwatershed has the smallest percentage of forested acreage with just under 14 percent. The Hoover Area subwatershed (070) has the greatest percentage of forested land cover with 34.5 percent of the subwatershed (table 3-14). In general, the majority of the forested acres within the study area are adjacent to the surface waters of the watershed and in steeper sloped areas where agriculture practices are limited.

Table 3-14. Forest Land Cover by Subwatershed

Subwatershed	Acres	Percent of Subwatershed
Headwaters-010	11,772.40	33.43
Culver Creek-020	2,034.00	23.74
Perfect Creek-030	1,163.79	18.16
Rattlesnake Creek-040	2,004.02	13.76
Prairie Run-050	1,267.87	23.03
Little Walnut Creek-060	6,373.26	30.43
Hoover Area-070	6,575.44	34.54
Duncan Run-080	1,858.15	16.91

Overall, the forested communities found within the study area are considered to be in good health. However, there are some concerns. The Emerald Ash Borer (EAB) has been found in Delaware, Licking, and Franklin Counties. The EAB larvae feed on the cambium layer of ash trees and usually kill the tree within 3-5 years. Ash is a major species in the forested ecosystem within the study area and the EAB could change the overall composition of these areas.

Agriculture

Agriculture is the largest land use of this watershed making up over 71 percent of the landscape. The most common row crops planted within the study area are soybeans, corn, and wheat (table 3-15). In 2008, soybeans were the most common row crop planted with an average of 43 percent of row crop land. The analysis of row crop production focused on four main counties in the study area (Franklin County agriculture information was not analyzed due to the small area and its urbanized nature). Corn was a close second with an average of 38 percent of row crop acreage.

Wheat, 7 percent, and hay, 12 percent, were the 3rd and 4th most common row crops. Table 3-12 gives the acres in the top four crops in each of the watershed's counties for 2008 (ODA, 2008). This table also gives the percentage of each crop in each county.

Table 3-15. Acres in Crops (and percent of row crop in 2008)

County	Corn (percent)	Soy (percent)	Wheat (percent)	Hay (percent)
Morrow	49,200 (37 percent)	58,600 (44 percent)	15,500 (12 percent)	8,700 (7 percent)
Delaware	45,300 (35 percent)	66,100 (51 percent)	10,500 (8 percent)	8,200 (6 percent)
Licking	57,700 (39 percent)	59,500 (41 percent)	6,100 (4 percent)	24,400 (17 percent)
Knox	54,800 (41 percent)	47,000 (35 percent)	5,800 (4 percent)	25,000 (19 percent)
Source: USDA, 2008				

The most common crop rotation is alternating corn to soybeans every year with wheat planted after the second rotation. Table 3-16 lists the most common row crops by percentage in the UBWC study area.

Table 3-16. Acres in Row Crop in the UBWC Study Area

County	Corn	Soy	Wheat
Acres	16,456	24,179	2,050
Percent of Watershed	14 percent	20 percent	2 percent
Source: NASS, 2007			

Livestock Inventory

Livestock operations are present in the watershed and table 3-17 shows the quantity of livestock in the four main watershed counties. These numbers are from the most recent livestock inventory completed by Ohio Department of Agriculture in 2008. The UBWC Water Quality Management Plan (Malcolm Pirnie, 1999) lists 383 acres categorized as Confined Animal Feeding Operation land use within the study area with the Little Walnut Creek and Culver Creek subwatersheds with the highest percentage of CAFO land at 1 percent and .9 percent.

Table 3-17. Amount of Livestock in Watershed Counties

County	Cattle & Calves	Milk Cows	Hogs & Pigs	Sheep & Lambs
Morrow	10,200	1,800	24,800	2,200
Knox	21,900	4,700	14,200	6,700
Licking	22,700	3,100	24,900	4,000
Delaware	4,100	n/a	23,900	1,400
Source: USDA, 2008				

The USDA Farm Service Agency (FSA) Livestock Compensation Program of 2003 for Ohio was created due to the drought in 2002. Because of this program specific livestock numbers for any

part of the watershed can be learned by working with FSA. If a geographic specific implementation project requires knowledge of livestock quantities this resource is available.

Grazing
Grazing does occur throughout the study area and is demonstrated by the amount of pasture land in the watershed. A thorough inventory of pasture land is needed to quantify the amount of unrestricted livestock access to surface waters.

Chemical Use Patterns
Agricultural chemical use patterns are a concern within the UBWC watershed. Hoover Reservoir provides drinking water to over 500,000 residents in the City of Columbus. High atrazine levels spurred past watershed efforts in the study area and let to the creation of the Upper Big Walnut Creek Water Quality Partnership, Special EQIP, and UBWC CREP. Atrazine levels have declined in Hoover as a result of these efforts. Continued participation in USDA farm bill programs like EQIP and CREP will be necessary to limit the impact agricultural chemicals can have on the UBWC surface waters.

Irrigation
Irrigation is not necessary in the UBWC watershed due to the amount of precipitation and relatively poorly drained soils.

Open Water
The OEPA-DSW data set identified a total of 2,611 acres or 2.15 percent of the study area to be in the open water land use category. Hoover Reservoir accounts for all the open water acreage in the study area. However, the City of Columbus lists the open water acreage for Hoover to be 3,272 acres and holds approximately 20.8 billion gallons of water. Further information about lakes and wetlands in the watershed can be found in the Surface Water sub-section of the Water resource section of this inventory.

Non-forested Wetlands
The 1999-2003 OEPA-DSW land use data set identified 79.5 acres of woody wetlands in the UBWC study area. This data set did not have a non-forested wetlands category. The Ohio Wetland Inventory did identify 722.6 acres of non-forested wetlands in the UBWC study area. Shallow marsh and scrub-shrub wetlands were most prevalent in the study area with 361 acres and 322 acres respectively. Forested wetlands dominate total acreage within the watershed with over 4,147 acres.

Protected Lands
Currently, there are four separate entities with the ability to hold conservation easements within the UBWC study area. The Genoa Township Land Conservation Association is a non-profit group working towards protecting the natural and scenic attributes found within Genoa Township. They currently hold easements on 107 acres of land within the township. The other three entities, Heart of Ohio RC&D, Delaware SWCD, and the City of Columbus, have yet to secure any conservation easements within the study area.
There are numerous township and city parks located within the watershed. The largest preserved areas are the Char-Mar Ridge Preserve and the Hoover Reservoir Park. The Char-Mar Ridge

Preserve, managed by Preservation Parks, is a 128 acre park comprised of mixed habitat. The park is located in northern Genoa Township adjacent to the Hoover Reservoir. The other large protected area is the Hoover Reservoir Park. This area is comprised of the land surrounding the reservoir and has an area of 4,706 acres.

Status and Trends

The increased urban development, particularly in the southern portion of the watershed, will continue to reshape the current land use practices in the UBWC study area. According to the U.S. Census, the population within the study area increased 22 percent from 2000 to 2005. This figure reaffirms the need to work with the existing urban communities to protect the water resources of the UBWC watershed.

Cultural Resources

There are no major historical, cultural, or recreational sites of significance within the UBWC study area.

Physical Attributes of Streams and Floodplain Areas

This section briefly describes the current conditions of the physical attributes of the surface waters and floodplain areas found in the study area. A more detailed analysis by subwatershed is performed in section 4.0 of this study plan.

Early Settlement Conditions

Much of the UBWC study area was forested prior to European settlement. The majority of the forested lands were covered by beech forests (88 percent) with pockets of Oak-Sugar maple (4 percent) and Elm-Ash Swamp (8 percent) forests making up the rest. Much of the existing forests were cleared in order to farm the fertile soils found in the study area. Over time, the poorly drained soils were drained using subsurface drainage systems and agricultural ditches were created to expedite the flow of excess water from the drained fields. Portions of existing channels were dredged and straightened to improve water flow and farming ease. Today, much of the watershed is in agricultural production with just over 58 percent devoted to this land use practice.

Channel and Floodplain Condition

The majority of floodplains within the study area seem to have a positive connection to the adjacent floodplains. Areas that have been channelized are generally in soils that are not representative of floodplain conditions. However, there are some land use practices that are compromising the physical integrity of floodplain acreage. Table 3-18 details the acreage of 100-year floodplain and percentage of 100-year floodplain for each subwatershed.

Table 3-18. Acreage and Percentage of 100-year Floodplain in Each Subwatershed

Subwatershed	Floodplain Acres	Percent of Watershed in Floodplain
Headwaters-010	1607.76	4.56
Culver Creek-020	471.77	5.50
Perfect Creek-030	358.53	5.59
Rattlesnake Creek-040	242.35	1.66
Prairie Run-050	417.60	7.59

Little Walnut Creek-060	834.22	3.98
Hoover Area-070	3517.80	18.48
Duncan Run-080	293.51	2.67
Whole Watershed	7743.55	6.38

Table 3-19 illustrates the land use practice found within the 100-year floodplain for the entire study area. Forested areas account for over 40 percent of the floodplain acreage while agricultural land use accounts for is the third 23 percent.

Table 3-19. Land Use Within 100-year Floodplain

Land Use	Acreage	Percent of 100-year floodplain
Agricultural	1798.76	23.23
Barren	0.38	0.01
Non Forested Wetlands	491.25	6.34
Open Water	2040.51	26.35
Shrub/scrub	53.73	0.69
Urban	170.30	2.20
Wooded	3190.18	41.19
Total	7745.03	100.00

Riparian Corridor Assessment

Riparian areas or stream buffers play a vital role in the physical, chemical, and biological health of aquatic ecosystems. Stream buffers can filter out harmful pollutants that are often contained in over-the-ground runoff. Most of the pollutants are contained within the soil particles. A properly maintained buffer helps eliminate the deposition of pollutant laden soil particles which increases the physical and chemical health of the stream. Buffers also provide habitat for aquatic and terrestrial organisms by providing the necessary habitat and food. Overhanging vegetation can also help to keep water cool during warmer seasons.

An examination of the land cover within stream corridors was carried out using the 1999-2003 OEPA-DSW cover map data set for the entire watershed. This analysis examined the area of land cover within a 100-foot buffer for all surface waters in the study area. These data are presented in table 3-20 below. The Headwaters (010) and Hoover Area (070) subwatersheds had the highest percentage of forested land cover within the 100-foot buffer areas with 61 percent each. Prairie Run, Culver Creek, and Duncan Run had the lowest percentage of forested cover with 35 percent, 37 percent, and 39 percent. Focus on developing riparian buffers should be greater within these subwatersheds. Perfect Creek subwatershed had the highest percentage of pastureland found within the 100-foot buffered areas. The percentage of row crop production within the Duncan Run, Culver Creek, and Rattlesnake Creek subwatersheds was highest with 53 percent, 48 percent, and 45 percent respectively. The subwatersheds with high pastureland and row crop production percentages within the 100-foot buffers are great candidates for stream buffer best management practices.

Table 3-20. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Each Subwatershed and the Whole Watershed. 1999-2003 OEPA-DSW Cover Map.

Sub-WS	Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
Headwaters	60.95	.88	5.28	32.35	.53	0
Culver Creek	37.14	2.50	12.15	47.94	.26	0
Perfect Creek	43.86	8.24	9.06	38.84	0	0
Rattlesnake Creek	39.95	3.96	11.17	44.92	0	0
Prairie Run	35.21	0	25.06	38.89	0	.79
Little Walnut Creek	44.45	3.14	13.07	39.34	0	0
Hoover Reservoir	60.97	0	23.12	19.56	0	9.29
Duncan Run	38.95	.53	4.88	53.53	0	2.11
Total	50.60	1.96	9.51	36.50	21	1.21

Number of Miles with Permanent Protection

There are no channels having permanent protection by means of Scenic River status or long term easements.

Officially Classified and/or Petition Ditches

Map 3-13 and table 3-21 includes all of the ditches on county maintenance throughout the watershed in Delaware County. An accurate account of petitioned ditches in Morrow, Knox, Licking, and Franklin Counties is not available at this time.

Table 3-21. Official/Petitioned Ditches in UBWC, Delaware County by Subwatershed

HUC	Unmaintained Ditch Miles	Maintained Ditch Miles	Total Ditch Miles
Headwaters-010	2.058	0.000	2.058
Culver Creek-020	3.358	0.000	3.358
Perfect Creek-030	1.526	0.000	1.526
Rattlesnake Creek-040	10.733	0.000	10.733
Prairie Run-050	3.135	0.244	3.379
Little Walnut Creek-060	12.590	1.061	13.651
Hoover Reservoir-070	16.242	0.000	16.242
Duncan Run-080	7.958	0.539	8.497
Whole WS	57.600	1.844	59.444

Dams

The Upper Big Walnut Creek Watershed Project area ends with the Hoover Dam in Franklin County. This dam creates the Hoover Reservoir. There are three identified low-head dams in the study area. All three are on the Big Walnut Creek and all three are adjacent to the Village of Sunbury (table 3-22).

Table 3-22. Low-head Dam Locations in Upper Big Walnut Creek Study Area

Dam	Stream	Description	Long.	Lat.	Township

ID					
68	Big Walnut Creek	Upstream of Hartford Road bridge in Sunbury, portage river left or right	-82.85	40.25	Trenton
69	Big Walnut Creek	Downstream of Hartford Road in Sunbury, portage river left with permission	-82.85	40.25	Berkshire
1028	Big Walnut Creek	North of Sunbury, near High Street & Greenbriar, portage river	-82.84	40.25	Trenton

Streams with Livestock Access

There is a well distributed amount of livestock in the Upper Big Walnut Creek Watershed Project area. Evident in the Livestock Inventory data presented in the Land Use section of this inventory, no county in the watershed is lacking livestock. Inventory of stream locations with livestock access have not been conducted.

Eroding Banks

Eroding banks due to obstructed stream flow is a concern in this watershed. Woody debris, road-stream crossings, uncontrolled livestock access, and an increase in stream discharge are leading causes of eroding stream banks. A detailed inventory of eroding stream banks has not been performed.

Riparian Levees

There is no information about riparian levees available for this watershed.

Woody Debris in Watercourses/ Logjams

Excess woody debris in watercourses has been a common concern throughout the public input process in generating this action plan. The overall consensus is there is a lack of direction or support from service agencies. Logjams within surface waters can build over time to the point that stream flow is restricted and overland flooding occurs. This leads to stream bank erosion at the site of the logjam as well as the site where flood waters reenter the stream.

Logjams may create storage of organic matter and nutrients thus keeping excess amounts from being exported downstream. This storage, along with the variety of hydrologic conditions caused by woody debris often creates advantageous conditions for diverse aquatic habitat. This more robust habitat in-turn uses up the stored organic matter and nutrients improving the streams water quality.

4.0 WATERSHED IMPAIRMENTS, RESTORATION AND PROTECTION GOALS, AND IMPLEMENTATION/ACTION PLAN

Upper Big Walnut Creek Headwaters Subwatershed

14 Digit HUC: 05060001130010
Location: Headwaters of Upper Big Walnut Creek River Mile 53.35
Drainage Area: 55.09 square miles, 35,230 Acres
Miles of Stream: 158
Average Sinuosity: 1.27

Watershed concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Monitoring downstream of development projects
- Fluctuating surface water flows from increased underground drainage
- Log jams and drainage issues
- Oil and gas transmission line failures (past issues)

Subwatershed Description

The Upper Big Walnut Creek Headwaters watershed is the largest of the eight subwatersheds in the project area. The subwatershed is defined as the area of land draining into the Upper Big Walnut Creek watershed. This watershed drains mostly agricultural and forested land in Morrow Delaware, and Knox Counties. The watershed includes portions of Gilead, Harmony, Bennington, and South Bloomfield Townships in Morrow County; Kingston, and Porter Townships in Delaware County; and Hilliar Township in Knox County (map 4-1). The Village of Marengo is located within the Headwaters subwatershed along with several other unincorporated areas. The highest subwatershed elevation is 1,419.3 feet and the lowest elevation is 999.7 feet. Total relief is 419.6 feet.

Table 4-1. Headwaters Subwatershed Stream Names and Stream Lengths

Stream Name	Length in Miles
Big Walnut Creek	23.49
Castro Run	4.24
Light Creek	6.32
Long Run	9.93
Mill Creek	4.68
Reynolds Run	8.68
Sugar Creek	10.76

The Upper Big Walnut Creek begins in Morrow County and flows for approximately 23 miles through the headwaters subwatershed. There are several unnamed tributaries to Big Walnut Creek along with Castro Run, Mill Creek, Light Creek, Reynolds Run, Sugar Creek, and Long Run (table 4-1).

This is a rural watershed with 58 percent agriculture land use and 33 percent forested land use (table 4-2 and map 4-2). Corn-soybean crop rotation dominates the 56 percent of row crop production in the watershed. There is some disconnect between the upper surface waters of the headwaters and their floodplains due to the straightening and dredging of the upper portions of the watershed. Typical ditching practices are utilized including, trapezoidal channels, one-side, and two-side cleanout. However, over 72 percent of the 100-year floodplain is forested with 25 percent being in agricultural production. The OEPA land cover data set from 1999-2003 was used to ascertain the land use within a 100' buffer around all surface waters. Agricultural production constitutes over 33 percent of the land use within a 100 foot buffer around watershed surface waters. Forested and wetland areas encompass over 61 percent and residential accounts for 5 percent of the 100 foot buffers (table 4-3).

Table 4-2. Headwaters Subwatershed Land Use

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	171	0.48
Coniferous Forest	0.00	0.00
Deciduous Forest	11,772	33.43
Pasture	604	1.72
Residential	2,724	7.74
Row Crops	19,897	56.49
Urban/Recreational Grasses	2	0.01
Woody Wetlands	48	0.14
Water	0.00	0.00
Total	35,218	100.00

Table 4-3. Headwaters Subwatershed Land Use Within 100' Stream Buffer

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	12	0.36
Coniferous Forest	0.00	0.00
Deciduous Forest	2,039	60.95
Pasture	30	0.88
Residential	164	4.92
Row Crops	1,082	32.35
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	18	0.53
Water	0.00	0.00
Total	3,344	100.00

Table 4-4. Ohio Wetland Inventory Acres for Headwaters Subwatershed

Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
29.1	53.4	55.9	6.8	546.9

Table 4-5. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Headwaters Subwatershed. 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
60.95	.88	5.28	32.35	.53	0

Soils

The major soils are Amanda, Bennington, Centerburg, and Pewamo on ground moraines and end moraines. Together these four soils comprise nearly 82 percent of the subwatershed. Nearly 3,094 acres or about 8.8 percent of the subwatershed are classified as alluvial (floodplain) soils that are subject to occasional flooding. Nearly 22,000 acres or about 62 percent of the soils have slopes greater than 2 percent and are subject to erosion. About 14 percent of the soils are considered moderately eroded. Tables 4-6 thru 4-9 provide acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils is given in the soil surveys of Delaware, Morrow, and Knox counties.

Table 4-6. Hydrologic Soil Group Classification for Headwaters Subwatershed (SSURGO)

Hydrologic Group Acres						
A/D	B	B/D	C	C/D	D	Not Rated
9	1,222	1,079	29,105	2,124	1,512	167

Table 4-7. Hydric Soil Ratings (acres) Headwaters Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
22	8	33,304	1,885

Table 4-8. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Headwaters Subwatershed

Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
14,311	15,000	43 percent	129	5,778

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 46 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. The Headwaters subwatershed has the highest percentage of moderately well drained soils acreage at 51 percent. Table 4-9 lists the acreage for each drainage class for the Headwaters subwatershed.

Table 4-9. Drainage Class Acreage for the Headwaters Subwatershed

Unknown	Moderately well drained	Poorly Drained	Somewhat poorly drained	Very poorly drained	Well drained
130	17,954	1,479	10,341	3,244	2,069

Water Quality

Biological
The Headwaters subwatershed streams have been given a WWH aquatic life use designation and the recreational use is Primary Contact Recreation (PCR). Ohio EPA (2005) reported that 10.84 miles of Big Walnut Creek, 1.0 miles of Reynolds Run, and 2.75 miles of Long Run were not meeting the WWH aquatic life use designation. Sugar Creek has 1.0 miles of stream in partial attainment of its WWH use designation (table 4-10).

Table 4-10. Headwaters Subwatershed Aquatic Life Use Designation and Attainment Status

Stream Name	Full attainment (miles)	Partial attainment (miles)	Non attainment (miles)
Big Walnut Creek	12.65		10.84
Castro Run	0.9		
Mill Creek	2.2		
Reynolds Run			1.0
Long Run	2.15		2.75
Sugar Creek	1.0	1.0	

The TMDL report lists flow alteration, habitat alteration, siltation, nutrients, pathogens, organic enrichment, and ammonia as causes of impairment. Of the reported causes of impairment, flow alteration, habitat alteration, and siltation were listed as having a major contribution to each segment of stream not meeting it's aquatic life use designation.

Stream sections in the Headwaters subwatershed that failed to meet the aquatic life use attainment status were assessed using the Qualitative Habitat Evaluation Index (QHEI), Integrated Biological Index (IBI), and the Invertebrate Community Index (ICI). Although several sampling stations obtained the target QHEI score of 60 for WWH the IBI and ICI scores did not reflect the physical habitat conditions. Biological communities were impacted by channel modifications (RM 72.5/73.6), siltation (RM 72.5/73.6), stream dewatering, and nutrient enrichment (OEPA, 2005).

Physical
There are no known man made dams present within this subwatershed and beaver activity is virtually non-existent. However, stream flow alteration is listed as a cause of impairment in the Big Walnut Creek TMDL. Channelization of primary headwater streams along with subsurface drainage systems are the leading sources of impairment when it comes to flow alteration. The dewatering of slow infiltrating soils through subsurface drainage systems, removes the lands natural ability to allow precipitation to slowly recharge watershed surface and ground waters. Channelization of surface waters creates a disconnect between the stream and its floodplain which allows for faster dewatering as the floodplains are not able to store excess runoff.

The Qualitative Habitat Evaluation Index, designed by OEPA, is a tool used to assess physical stream habitat characteristics. For WWH use designation the goal is for a QHEI score of 60. This subwatershed has a total of 26 sampling stations where the QHEI was performed 1998-2004. The average score for these sites is 68.9 with six stations having QHEI scores below the desired WWH threshold of 60 (table 4-11).

Table 4-11. OEPA Sampling Stations in Headwaters Subwatershed

Station	River	River Mile	QHEI	IBI	ICI
S02100 52.402000	Big Walnut Creek	52.4	69.5	38	44
S02100 54.601996	Big Walnut Creek	54.6	75.5	37	34
S02100 54.602000	Big Walnut Creek	54.6	73.0	46	30
S02100 60.001982	Big Walnut Creek	60.0	0.0	42	34
S02100 60.001996	Big Walnut Creek	60.0	80.0	46	40
S02100 60.001998	Big Walnut Creek	60.0	72.0	42	0
S02100 60.002000	Big Walnut Creek	60.0	0.0	0	42
S02100 60.002004	Big Walnut Creek	60.0	81.0	0	0
S02100 61.901988	Big Walnut Creek	61.9	77.5	42	0
S02100 61.901999	Big Walnut Creek	61.9	68.5	44	0
S02100 61.902000	Big Walnut Creek	61.9	0.0	46	0
S02100 65.101982	Big Walnut Creek	65.1	0.0	41	28
S02100 65.101988	Big Walnut Creek	65.1	64.5	28	0
S02100 66.601982	Big Walnut Creek	66.6	0.0	32	32
S02100 66.602000	Big Walnut Creek	66.6	58.5	34	0
S02100 73.602000	Big Walnut Creek	72.5	55.5	32	0
S02102 0.102000	Sugar Creek	0.1	77.0	46	0
S02102 5.302000	Sugar Creek	5.3	71.0	46	0
S02103 0.701997	Long Run	0.8	85.5	36	0
S02103 0.702000	Long Run	0.7	73.0	48	0
S02103 3.602000	Long Run	3.6	69.0	34	0
S02103 4.902000	Long Run	4.9	56.5	20	0
S02104 .0702000	Reynolds Run	0.7	59.0	32	0
S02104 4.902000	Reynolds Run	4.9	53.5	28	0
S02105 0.402000	Castro Run	0.4	57.0	36	0
S02170 1.302000	Mill Creek	1.3	70.5	40	0

Chemical

As covered in previous planning and implementation efforts, pesticide runoff continues to be a concern for this watershed. Overland runoff or infiltration into subsurface drainage systems continues to be the main source for this nonpoint source pollution. OEPA reports in the Big Walnut Creek TMDL that nutrients, pathogens, organic enrichment, and ammonia are causes of impairment to reaches within this subwatershed. Possible sources for these impairments are range land activity and failing home sewage treatment systems.

Ohio EPA calculated the total fecal coliform and phosphorous loads for the entire 14-digit subwatershed and listed the necessary reduction from current levels in order to meet the TMDL. Fecal coliform, expressed in colony forming units (*cfu*), was found to have an existing load of 183 and needs a 90 percent reduction to achieve the TMDL. Uncontrolled livestock access to streams was listed as the number one nonpoint source for fecal coliform in this subwatershed. Total phosphorous, expressed as pounds per year, had a 35,403 pounds per year load. A 65 percent reduction is needed to conform to the TMDL. Livestock in streams and failing home sewage treatment systems were listed as the main nonpoint sources.

Problem Statements

Problem Statement 1:
Nearly 12 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by physical habitat degradation (channel modifications) from direct alteration of the stream channel and removal of riparian vegetation.

Goal 1: Improve in-stream physical habitat to 12 miles of impaired stream channel to increase and maintain QHEI scores at 60 points or more on channels under 2,000 acres of drainage area.

- Objective 1: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat resulting from the alteration of natural drainage.
  - Action 1: Develop contact list for landowners adjacent to impaired stream channel segments
  - Action 2: Make available to all owners of land adjacent to impaired stream segments copies of Ohio Drainage Report, Ohio Drainage Law (summary), and draft Ohio Drainage Manual.
  - Action 3: Provide landowner drainage management workshops upon request and as needed for new group projects.
  - Action 4: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended drainage actions
- Objective 2: Establish procedure to assure that all channel management activities and practices under maintenance minimize negative QHEI score impacts.
  - Action 1: Score all new channel management projects prior to undertaking modifications or restorations.
  - Action 2: Establish review team to evaluate new project proposals and determine projected QHEI score.
- Objective 3: Apply current best management strategies and practices on all new stream channel modification and existing maintenance projects.
  - Action 1: Adhere to all NRCS drainage maintenance specifications in FOTG
  - Action 2: Develop watershed drainage evaluation service to review areas to be considered for maintenance using table format inspection form proposed in the draft Ohio Drainage Manual.
  - Action 3: Seek additional incentives to encourage adoption of best management practices for channel maintenance activity by exploring market-based approaches, such as water quality credit trading, and utilizing special grants.

Action 4: Require all new drainage projects be placed on permanent county maintenance

Goal 2: Increase riparian vegetation along 12 miles of impaired stream to help increase and maintain QHEI scores at 60 points or more.

Objective: Establish 15 new acres of herbaceous riparian buffers (filter strips) per year for 3 years.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Provide landowners with an opportunity to attend field tours that demonstrate the benefits of riparian buffers

Problem Statement 2: About 15.5 miles of stream have only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by flow alteration from channel modifications (direct alteration of the stream channel) and agricultural tile drainage systems (dewatering).

Goal: Improve stream flow dynamics (highs lower and lows higher) from dewatering by unmanaged agricultural drainage systems by about 1 percent

Objective: Install 3 drainage water management practices per year to "directly manipulate (control)" drainage discharge and retention on waters impaired by agricultural tile drainage dewatering.

Action 1: Host field day with partners to demonstrate practices offered and their environmental benefits

Action 2: Target one direct mailing to producers per year

Problem Statement 3: About 12 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 81,960 ton of excess sediment loading (embeddedness) from adjacent cropland. In addition, the sum of the substrate, channel, and riparian categories from the QHEI assessment at RM 72.5 and 66.6 on Big Walnut Creek, RM 0.7 on Reynolds Run, and RM 4.9 on Long Run range from 0.5 to 5.0 points less than the TMDL sediment target score of $\geq$ 33.

Goal 1: Reduce soil erosion from unprotected cropland by about 16,390 tons per year (.82 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 3,300 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 850 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 15 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 4: About 11 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 16,800 pounds per year of excess nutrient enrichment (phosphorus) from agricultural runoff and agricultural tile drainage systems.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by about 4,200 pounds per year for 4 consecutive years.

Objective 1: Treat 3,300 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 15 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit farmers through continued and increased collaboration with the Delaware, Knox, and Morrow SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 4: Establish 2 critical area plantings areas to control runoff

Action: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Contact eligible landowners

Action 2: Assess site suitability

Action 3: Install bioreactor

Objective 2: Install 10 structures for water control and drainage water management practices to control phosphates.

Action 1: Contact eligible landowners

Action 2: Assess site suitability

Action 3: Install water control structures

Problem Statement 5: About 14.5 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 960 pounds per year of excess nutrient enrichment (phosphorus) from livestock (cattle) access to streams.

Goal: Reduce phosphate loading due to livestock manure directly entering streams by an average of about 190 pounds per year for 5 consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Problem Statement 6: About 12 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 1,800 pounds per year of excess nutrient enrichment (phosphorus) from failing home sewage treatment systems (HSTS).

Goal: Reduce phosphorus loading from failing on-site HSTS discharge by about 1,800 pounds per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 7: About 11 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 65 ton of excess nutrient enrichment (nitrates) from cropland runoff and agricultural tile drainage systems.

Goal 1: Reduce nitrate loading from agricultural cropland runoff by 10 percent or about 1.76 pounds per acre per year for 4 consecutive years.

Objective 1: Treat 50 cropland fields per year (approximately 3,300 acres) with nitrate reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Design, print and distribute one fact sheet describing practices offered and economic and environmental benefits.

Action 2: Target outreach (specifically a fact sheet) and quality technical assistance to generate higher levels of nitrate reduction implementation.

Action 3: Train agriculture professionals (Certified Crop Advisors) in EQIP Management Systems approach, program availability and benefits

Action 4: Engage farmers to enroll fields

Action 5: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 6: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Goal 2: Reduce nitrate loading from agricultural cropland tile drainage systems by about 5 pounds per acre per year.

Objective 1: Install one (1) denitrifying bioreactor to trap nitrates

Action 1: Contact eligible landowners
Action 2: Assess site suitability
Action 3: Install bioreactor

Objective 2: Install 10 structures for water control and drainage water management practices to control nitrates.

Action 1: Contact eligible landowners
Action 2: Assess site suitability
Action 3: Install water control structures

Goal 3: Improve nitrate use efficiency by 25-40 pounds per acre per year on average.

Objective 1: Engage up to 15 to 20 producers to implement adaptive management approach to nutrient management.

Action 1: Develop partnership with certified crop advisors
Action 2: Acquire new aerial imagery annually
Action 3: Annually collect and analyze key indicators of nutrient use efficiency using cornstalk nitrate testing and yield data.
Action 4: Compare relative efficiency and effectiveness of different management practices using replicated strip trials. Statistically analyze results from strip trials using Analysis of Variance (ANOVA) and PROC MIXED
Action 5: Document/quantify edge-of-field and downstream water quality benefits of practice implementation using the ARS CEAP infrastructure.
Action 6: Review analysis of data for publication as fact sheets, updates, and articles in scientific and farm publications
Action 7: Advance adaptive management approach to nutrient management and quantify benefits using Ph.D. graduate thesis.
Action 8: Implement extensive communications and outreach strategy targeted to crop consultants, district staff, and additional federal and state agency experts to ensure technical experts have the information they need to understand the value of a networked, adaptive management approach and how it can be implemented at the local and regional watershed level.
Action 9: Target outreach and quality technical assistance to generate higher levels of nitrate efficiency implementation.
Action 10: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.
Action 11: Involve farmers in nutrient efficiency network to advance adaptive management approach to nitrate management and increase accountability and validation of impact.
Action 12: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Problem Statement 8: Streams in this watershed periodically exceed the maximum contaminant level of **atrazine** allowable in finished drinking water caused by pesticide runoff or leaching into

subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 60 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland (corn acreage) by about .003 pounds per acre per year.

Objective 1: Treat up to 5,000 acres of corn with non-atrazine herbicide product.

Action 1: Develop special environmental quality incentive program to include financial incentive for pesticide management on corn acreage.

Action 2: Develop conservation farm plans with eligible producers to eliminate usage of atrazine on corn acreage.

Objective 2: Establish 15 new acres of filter strips per year to trap or avoid atrazine entering the stream.

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Goal 2: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 3: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 2: Report concerns to UBWC WQ Partnership

Goal 4: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average
Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 9: About 11 miles of stream have only fair levels of biological performance (IBI/ICI scores not meeting WQS) caused by organic enrichment (low DO) from numerous (unspecified) sources of oxidizable material.

Goal 1: Reduce nutrient loading from numerous unspecified sources by about 500 pounds per year to increase and maintain dissolved oxygen levels to 5.0 mg/l average over a 24 hour period and 4.0 mg/l instantaneous minimum.

Objective: Establish 15 new acres of filter strips per year to trap or control nutrients

Action 1: Update UBWC CREP brochure to reflect program changes
Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.
Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.
Action 4: Recruit landowners through continued and increased collaboration with the Delaware, Knox, and Morrow SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Goal 2: Increase riparian vegetation along 11 miles of impaired stream per year to increase and maintain dissolved oxygen levels to 5.0 mg/l average over a 24 hour period and 4.0 mg/l instantaneous minimum.

Objective: Develop wooded riparian zones by constructing 0.5 miles of one-sided ditch maintenance practices with setbacks for maintenance.

Action 1: Seek funding to compensate landowners for loss of land on one-side or two stage drainage projects.
Action 2: Place new drainage projects on permanent county maintenance

Problem Statement 10: About 15.5 miles of stream are not meeting the primary contact recreational use designation caused by the presence of about 165 colony forming units (*cfu*) per year of excess pathogen loading (fecal coliform and *E. coli*) from livestock manure runoff and failing home sewage treatment systems (HSTS).

Goal 1: Reduce pathogenic bacteria from livestock (cattle) manure runoff by about 33 (*cfu*) on average per year for five consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Goal 2: Reduce pathogenic bacteria from failing HSTS discharge by about 0.47 *cfu* per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Culver Creek Watershed

14 Digit HUC: 05060001130020
Location: Culver Creek and Tributaries River Mile 53.35
Drainage Area: 13.39 square miles, 8,567 Acres
Miles of Stream: 32.6
Average Sinuosity: 1.26

Concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Monitoring downstream of development projects
- Log jams within surface waters and drainage related issues
- Improper forestry practices leaving large quantities of debris within riparian area which leads to increased log jams

Subwatershed Description

Culver Creek is the sixth largest of the eight subwatersheds in the project area. The subwatershed is defined as the area of land draining into Culver Creek watershed. This watershed drains mostly agricultural and forested land in Delaware and Knox Counties. Portions of this subwatershed lie within Porter and Trenton Townships in Delaware County and Hilliar Township in Knox County (map 4-3). The highest subwatershed elevation is 1,355.3 feet and the lowest elevation is 1,019.4 feet. Total relief is 335.9 feet.

Culver Creek begins in southwestern Knox County and flows southwest through portions of Delaware County for 11.3 miles before joining the Big Walnut Creek. None of the small feeder streams to Culver Creek are named on the USGS topographic maps but local names include: Beard Ditch, Wilcox Run, South Branch Culver Creek, Southeast Branch Culver Creek, and Condit Ditch.

The Culver Creek subwatershed is a rural watershed with 65 percent of the area being in agricultural production and 24 percent forested land cover (table 4-12 and map 4-4). There are no major incorporated or unincorporated areas within this subwatershed. Corn-soybean crop rotation dominates the 59 percent of row crop production in the watershed. The 100-year floodplain is comprised of 43 percent agricultural production, 44 percent forested land, and 13 percent residential areas. The OEPA land cover data set from 1999-2003 was used to ascertain the land use within a 100' buffer around all surface waters. Agricultural production constitutes 50 percent of the land use within a 100 foot buffer around watershed surface waters. Forested and wetland areas encompass over 37 percent and residential areas 11 percent of the 100 foot buffers (table 4-13).

Table 4-12. Culver Creek Subwatershed Land Use

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00

Deciduous Forest	2,034	23.74
Pasture	475	5.54
Residential	884	10.32
Row Crops	5,076	59.24
Urban/Recreational Grasses	68	0.79
Woody Wetlands	31	0.36
Water	0.00	0.00
Total	8,567	100.00

Table 4-13. Culver Creek Subwatershed Land Use Within 100' Stream Buffer

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	257	37.14
Pasture	17	2.50
Residential	77	11.09
Row Crops	332	47.94
Urban/Recreational Grasses	7	1.06
Woody Wetlands	2	0.26
Water	0.00	0.00
Total	693	100.00

Table 4-14. Ohio Wetland Inventory Acres Culver Creek Subwatershed

Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
9.4	30.9	66.8	2.6	544.2

Table 4-15. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Culver Creek Subwatershed, 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
37.14	2.50	12.15	47.94	.26	0

Soils

The major soils are Bennington, Centerburg, and Pewamo on ground moraines and end moraines. Together these three soils comprise about 77 percent of the subwatershed. Nearly 469 acres or about 5.5 percent of the subwatershed are classified as Lobdell, Shoals, and Sloan soils which are alluvial (floodplain) soils that are subject to occasional flooding. Over 4,300 acres or about 51 percent of the soils have slopes greater than 2 percent and are subject to erosion. About 5 percent of the soils are considered moderately eroded. Tables 4-16 thru 4-19 provide acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils is given in the soil surveys of Delaware and Knox counties.

Table 4-16. Hydrologic Soil Group Classification for Culver Creek Subwatershed (SSURGO)

Hydrologic Group Acres						
A/D	B	B/D	C	C/D	D	Not Rated
2.4	281.2	251.7	5,803.1	2,131.7	81.9	15.3

Table 4-17. Hydric Soil Ratings (acres) Culver Creek Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
33	8	8,205	322

Table 4-18. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Culver Creek Subwatershed

Prime farmland Acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
1,367	6,760	79 percent	123	317

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 80 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-19 lists the acreage for each drainage class for Culver Creek subwatershed.

Table 4-19. Drainage Class Acreage for Culver Creek Subwatershed

Unknown	Moderately well drained	Poorly Drained	Somewhat poorly drained	Very poorly drained	Well drained
15	1,637	33	4,295	2,435	153

Water Quality

Biological

The Culver Creek subwatershed has been given a WWH aquatic life use designation and a primary contact recreation (PCR) designation for recreational use. The surface waters are not currently achieving the PCR designation due to peak and average levels of *E. coli* and fecal coliform, except that the fecal coliform non-attainment is only occurring at peak levels of bacteria. Ohio EPA (2005) reported that 1.1 miles of Culver Creek was in partial attainment status for its use designation (table 4-20). One unnamed tributary to Culver Creek was reported to have one mile in full attainment of it's WWH aquatic life use designation. The Total Maximum Daily Loads for the Big Walnut Creek Watershed (TMDL) report lists flow alteration, siltation, nutrients, pathogens, organic enrichment, and ammonia as causes of impairment. Sources for the impairment are listed as non-irrigated crop production and failing home sewage treatment systems (HSTS).

Table 4-20. Culver Creek Subwatershed Aquatic Life Use Designation and Attainment Status

Stream Name	Full attainment (miles)	Partial attainment (miles)	Non attainment (miles)
Culver Creek	3.9	1.1	
Tributary to Culver Creek	1.0		

With only 1.1 miles of stream listed as partial attainment, the Qualitative Habitat Evaluation Index (QHEI) reflects the good overall health of this subwatershed. However, one area of concern is Culver Creek at river mile 4.5 where the TMDL reported high levels of nutrients which led to a low level of dissolved oxygen. The QHEI score at this site was 56.5, slightly lower than the recommended target score of 60 points. The high influence attribute is cited as maximum pool depth of less than 40 cm and the moderate influence attributes were cited as hardpan substrate origin, fair or poor channel development, and no fast current. The Index of Biotic Integrity (IBI) score for this site was slightly lower than the majority of sampling sites within the subwatershed but within range for the area. However, the Invertebrate Community Index (ICI) score for this site was listed as fair and led to the partial attainment status for this reach of stream (table 4-21).

Physical

The average QHEI score for this subwatershed is 76.2 (table 4-21) which exceeds the recommended score of 60 for the WWH aquatic life use designation. One area of concern, as listed in the TMDL is siltation. Siltation becomes a concern in aquatic environs when the interstitial space is filled with excess sediments. These spaces are crucial to the macro-invertebrate community within the aquatic system. Excess instream siltation could lead to lower ICI scores in the future.

Table 4-21. OEPA Sampling Stations in Culver Creek Subwatershed

Station	River	River Mile	QHEI	IBI	ICI
S02100 27.001991	Big Walnut Creek	27.1	81.0	45	46
S02100 37.201989	Big Walnut Creek	37.3	84.0	40	0
S02100 37.201991	Big Walnut Creek	37.2	85.5	41	38
S02100 37.202000	Big Walnut Creek	37.2	84.5	32	34
S02101 0.102000	Culver Creek	0.1	0.0	0	0
S02101 3.302000	Culver Creek	3.3	75.0	40	0
S02101 4.502000	Culver Creek	4.5	56.5	38	0
S02101 6.702000	Culver Creek	6.7	0.0	12	0
S02336 0.102000	Tributary to Culver Creek (RM 3.32)	0.7	67	40	0

Chemical

As covered in previous planning and implementation efforts, pesticide runoff continues to be a concern for this subwatershed. Overland runoff or infiltration into subsurface drainage systems

continues to be the main source for this nonpoint source pollution. The Big Walnut Creek TMDL lists organic enrichment, pathogens, and nutrients as the main causes of impairment to reaches within this subwatershed. Possible sources for these impairments are agricultural land use and failing home sewage treatment systems.

Ohio EPA calculated the total fecal coliform and phosphorous loads for the entire 14-digit subwatershed and listed the necessary reduction from current levels in order to meet the TMDL. Fecal coliform, expressed in colony forming units (*cfu*), was found to have an existing load of 20 and needs a 78 percent reduction to achieve the TMDL. Livestock operations or manure field applications was listed as the number one nonpoint source for fecal coliform in this subwatershed. Total phosphorous, expressed as pounds per year, had a 11,661 pounds per year load. An 83 percent reduction is needed to conform to the TMDL. Failing HSTS and livestock operations/manure application were listed as the main nonpoint sources.

Problem Statements

Problem Statement 1: About 1.1 miles of stream have only fair levels of biological performance (IBI/ICI/QHEI scores not meeting water quality standards (WQS)) caused by flow alteration from agricultural tile drainage systems (dewatering).

Goal: Improve stream flow dynamics (highs lower and lows higher) from dewatering by unmanaged agricultural drainage systems by about 1 percent

Objective: Install 1 drainage water management practice per year to "directly manipulate (control)" drainage discharge and retention on waters impaired by agricultural tile drainage dewatering.

Action 1: Host field day with partners to demonstrate practices offered and their environmental benefits

Action 2: Target one direct mailing to producers per year

Problem Statement 2: About 1.1 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by 17,100 ton of excess sediment loading (embeddedness) from adjacent cropland. In addition, the sum of the substrate, channel, and riparian categories from the QHEI assessment at RM 4.5 on Culver Creek is 1.5 points less than the TMDL sediment target score of ≥ 33.

Goal: Reduce soil erosion from unprotected cropland by about 3,420 tons per year (.67 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 215 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 215 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 5 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Problem Statement 3: About 1.1 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 6,400 pounds per year of excess nutrient enrichment (phosphorus) from agricultural runoff and agricultural tile drainage systems.

Goal: Reduce phosphate loading from agricultural cropland runoff by 1,200 pounds per year for 5 consecutive years.

Objective 1: Treat 3,300 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 15 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit farmers through continued and increased collaboration with the Delaware, Knox, and Morrow SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 3: Establish 2 acres critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Problem Statement 4: About 1.1 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 120 pounds per year of excess nutrient enrichment (phosphorus) from livestock (cattle) access to streams.

Goal: Reduce phosphate loading due to livestock manure directly entering streams by an average of about 24 pounds per year for 5 consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Problem Statement 5: About 1.1 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 2,200 pounds per year of excess nutrient enrichment (phosphorus) from failing home sewage treatment systems (HSTS).

Goal: Reduce phosphorus loading from failing on-site HSTS discharge by about 2,200 pounds per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 6: About 1.1 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 17 ton per year of excess nutrient enrichment (nitrates) from cropland runoff and agricultural tile drainage systems.

Goal: Reduce nitrate loading from agricultural cropland runoff by 10 percent or about 1.76 pounds per acre per year for 5 consecutive years.

Objective: Treat approximately 1,800 cropland acres per year with nitrate reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Design, print and distribute one fact sheet describing practices offered and economic and environmental benefits.

Action 2: Target outreach (specifically a fact sheet) and quality technical assistance to generate higher levels of nitrate reduction implementation.

Action 3: Train agriculture professionals (Certified Crop Advisors) in EQIP Management Systems approach, program availability and benefits

Action 4: Engage farmers to enroll fields

Action 5: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 6: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Goal 3: Improve nitrate use efficiency by 25-40 pounds per acre per year on average.

Objective 1: Engage producers to implement adaptive management approach to nutrient management.

Action 1: Develop partnership with certified crop advisors

Action 2: Collect and analyze key indicators of nutrient use efficiency using cornstalk nitrate testing and yield data.

Action 3: Compare relative efficiency and effectiveness of different management practices using replicated strip trials.

Action 4: Document/quantify edge-of-field and downstream water quality benefits of practice implementation using the ARS CEAP infrastructure.

Action 5: Advance adaptive management approach to nutrient management and quantify benefits.

Action 6: Implement communications and outreach strategy targeted to crop consultants, district staff, and additional federal and state agency experts to ensure technical experts have the information they need to understand the value of a

networked, adaptive management approach and how it can be implemented at the local and regional watershed level.

Action 7: Target outreach and quality technical assistance to generate higher levels of nitrate efficiency implementation.

Action 8: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 9: Involve farmers in nutrient efficiency network to advance adaptive management approach to nitrate management and increase accountability and validation of impact.

Action 10: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Problem Statement 7: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 15 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland (corn acreage) by .003 pounds per acre per year.

Objective 1: Treat 200 acres of corn with non-atrazine herbicide product.

Action 1: Develop special environmental quality program to include financial incentive for pesticide management on corn acreage.

Action 2: Develop conservation farm plans with eligible producers to eliminate usage of atrazine on corn acreage.

Objective 2: Establish 5 new acres of filter strips per year to trap or avoid atrazine entering the stream.

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Goal 2: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 3: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits
Action 2: Report concerns to UBWC WQ Partnership

Goal 4: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average
Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 8: About 1.1 miles of stream have only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by ammonia from failing home sewage treatment systems.

Goal: Reduce ammonia discharge from failing HSTS.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.
Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.
Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.
Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.
Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 9: About 1.1 miles of stream have only fair levels of biological performance (IBI/ICI scores not meeting WQS) caused by organic enrichment (low DO) from numerous (unspecified) sources of oxidizable material.

Goal: Reduce nutrient loading from numerous unspecified sources to increase and maintain dissolved oxygen levels to 5.0 mg/l average over a 24 hour period and 4.0 mg/l instantaneous minimum.

Objective: Establish 5 new acres of filter strips per year to trap or control nutrients

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit landowners through continued and increased collaboration with the Delaware and Knox County SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Problem Statement 10: About 1.1 miles of stream are not meeting the primary contact recreational use designation caused by the presence of about 15 colony forming units (*cfu*) per year of excess pathogen loading (fecal coliform and *E. coli*) from livestock manure runoff and failing home sewage treatment systems (HSTS).

Goal 1: Reduce pathogenic bacteria from livestock (cattle) manure runoff by about 3 (*cfu*) on average per year for five consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Goal 2: Reduce pathogenic bacteria from failing HSTS discharge by about 0.58 *cfu* per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Perfect Creek Watershed

14 Digit HUC: 05060001130030
Location: Perfect Creek and Tributaries River Mile 50.43
Drainage Area: 10.02 square miles, 6,410 Acres
Miles of Stream: 22.2
Average Sinuosity: 1.30

Concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Log jams in streams and related drainage issues
- Fluctuating surface water flows from increased underground drainage
- Improper forestry techniques

Watershed Description

Perfect Creek is the seventh largest of the eight subwatersheds in the project area. The subwatershed is defined as the area of land draining into the Perfect Creek watershed. This watershed drains mostly agricultural and forested land in Delaware, Licking and Knox Counties. Portions of this subwatershed lie within Hilliar Township in southwestern Knox County; Porter and Trenton Townships in Delaware County; and Hartford Township in northwestern Licking County (map 4-5). The highest subwatershed elevation is 1,206.4 feet and the lowest elevation is 962.3 feet. Total relief is 244.1 feet.

Perfect Creek begins in the northwest corner of Licking County and flows due west for 9.5 miles into Delaware County where it meets Big Walnut Creek just north of Sunbury. There are several unnamed tributaries to Perfect Creek including parts of Big Walnut Creek and Dry Run. Although not named on the USGS topographic maps, local stream names include: Green Run and Bulrush Run.

Nearly to 77 percent of the Perfect Creek subwatershed is in agricultural production with 67 percent in row crop production and 10 percent in pasture land (table 4-22 and map 4-6). The 100-year floodplain is comprised of 26 percent agricultural production and 68 percent forested. The OEPA land cover data set from 1999-2003 was used to ascertain the land use within a 100' buffer around all surface waters. Agricultural production constitutes over 47 percent of the land use within a 100 foot buffers around watershed surface waters. Forested areas encompass over 44 percent and residential 9 percent of the 100 foot buffers (table 4-13).

Table 4-22. Perfect Creek Subwatershed Land Use

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	1,164	18.16
Pasture	632	9.86

Residential	312	4.87
Row Crops	4,295	67.00
Urban/Recreational Grasses	7	0.11
Woody Wetlands	0.00	0.00
Water	0.00	0.00
Total	6,410	100.00

Table 4-23. Perfect Creek Subwatershed Land Use Within 100' Stream Buffer

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	208	43.86
Pasture	39	8.24
Residential	43	9.06
Row Crops	184	38.84
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	0.00	0.00
Total	474	100.00

Table 4-24. Ohio Wetland Inventory Acres for Perfect Creek Subwatershed

Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
13.8	15.7	25.1	3.1	267.3

Table 4-25. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Perfect Creek Subwatershed. 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
43.9	8.2	9.1	38.8	0	0

Soils

The major soils are Bennington, Centerburg, and Pewamo on ground moraines and end moraines. Together these three soils comprise about 88 percent of the subwatershed. Nearly 316 acres or about 5.0 percent of the subwatershed are classified as Lobdell and Sloan soils which are alluvial (floodplain) soils that are subject to occasional flooding. Nearly 2,700 acres or about 42 percent of the soils have slopes greater than 2 percent and are subject to erosion. About 5 percent of the soils are considered moderately eroded. Tables 4-26 thru 4-29 provide acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils is given in the soil surveys of Delaware, Licking, and Knox counties.

Table 4-26. Hydrologic Soil Group Classification for Perfect Creek Subwatershed (SSURGO)

Hydrologic Group Acres

A/D	B	B/D	C	C/D	D	Not Rated
	90.9	324.4	4,301.3	1,564.5	94.3	34.2

Table 4-27. Hydric Soil Ratings (acres) Perfect Creek Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
453	22	5,680	254

Table 4-28. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Perfect Creek Subwatershed

Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
1,023	5,066	79 percent	66	254

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 82 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-29 lists the acreage for each drainage class for Perfect Creek subwatershed.

Table 4-29. Drainage Class Acreage for Perfect Creek Subwatershed

Unknown	Moderately well drained	Poorly Drained	Somewhat poorly drained	Very poorly drained	Well drained
34	1,197	46	3,083	1,937	113

Water Quality

Biological

The Perfect Creek subwatershed has been given a WWH aquatic life use designation and is meeting the use designation at all sampling points. This subwatershed is also achieving its Recreational Use designation of PCR. The IBI and ICI scores, collected at three monitoring sites, were within the acceptable range to meet the WWH aquatic life use designation.

Physical

The average QHEI score for this subwatershed is 75 (table 4-30) which exceeds the recommended score of 60 for the WWH aquatic life use designation. At the present time, the Perfect Creek subwatershed does not have a TMDL established for the physical habitat or biology.

Table 4-30. OEPA Sampling Stations in Perfect Creek Subwatershed

Station	River	River	QHEI	IBI	ICI

		Mile			
S02100 27.002000	Big Walnut Creek	26.7	83.5	52	48
S02100 50.402000	Big Walnut Creek	50.3	76.5	0	0
S02100 52.402000	Big Walnut Creek	52.4	69.5	38	44
S02160 1.002000	Perfect Creek	1	59	0	0
S02160 4.702000	Perfect Creek	4.7	71.5	36	0

Chemical
As in other subwatersheds, pesticide runoff continues to be a concern. Overland runoff or infiltration into subsurface drainage systems continues to be the main source for this nonpoint source pollution. Phosphorous and fecal coliform continue to be a concern in this subwatershed. Possible sources for these impairments are agricultural land use and failing home sewage treatment systems.

Ohio EPA calculated the total fecal coliform and phosphorous loads for the entire 14-digit subwatershed and listed the necessary reduction from current levels in order to meet the TMDL. Fecal coliform, expressed in colony forming units (*cfu*), was found in Big Walnut Creek (RM53.4-50.4) to have an existing load of 15 and needs a 78 percent reduction to achieve the TMDL. Livestock operations or manure field applications was listed as the number one nonpoint source for fecal coliform in this subwatershed. Total phosphorous, expressed as pounds per year, had a 9,471 pounds per year load in Perfect Creek. A 62 percent reduction is needed to conform to the TMDL. Cropland, pasture land, and failing HSTS were listed as the main nonpoint sources.

Problem Statements

Problem Statement 1: About 22 miles of stream has an estimated 14,470 ton of excess sediment loading (embeddedness) from adjacent cropland.

Goal 1: Reduce soil erosion from unprotected cropland by about 2,894 tons per year (.67 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 200 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 180 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 5 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Install 1 grade stabilization structures to trap sediments before entering the stream.

Action: Target outreach and quality technical assistance to generate higher levels of grade stabilization structure implementation.

Objective 6: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 2: About 22.2 miles of stream requires about a 58 percent reduction (3,600 pounds) in total phosphorus from cropland to meet its TMDL allocation even though it is in full attainment for aquatic life, primary contact recreational uses, and has IBI and ICI scores meeting water quality standards.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by about 725 pounds per year for 5 consecutive years.

Objective 1: Treat an additional 480 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 5 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit farmers through continued and increased collaboration with the Delaware and Licking SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 3: Establish 2 acres of critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control phosphates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Problem Statement 3: About 22.2 miles of stream requires about a 58 percent reduction (65 pounds) in total phosphorus from livestock (cattle) access to streams to meet its TMDL allocation even though it is in full attainment for aquatic life, primary contact recreational uses, and has IBI and ICI scores meeting water quality standards.

Goal: Reduce phosphate loading due to livestock manure directly entering streams by an average of about 13 pounds per year for 5 consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Problem Statement 4: About 22.2 miles of stream requires about a 58 percent reduction (4,070 pounds) in total phosphorus from failing household sewage treatment systems to meet its TMDL allocation even though it is in full attainment for aquatic life, primary contact recreational uses, and has IBI and ICI scores meeting water quality standards

Goal: Reduce phosphorus loading from failing on-site HSTS discharge by about 4,070 pounds per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

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Problem Statement 5: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 13 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 2: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 2: Report concerns to UBWC WQ Partnership

Goal 3: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average

Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 6: About 22.2 miles of stream requires about an 85 percent reduction or about 11 colony forming units (*cfu*) in excess pathogen loading (fecal coliform and *E. coli*) from livestock (cattle) manure runoff and failing home sewage treatment systems (HSTS) to meet its TMDL allocation even though it is in full attainment for aquatic life, primary contact recreational uses, and has IBI and ICI scores meeting water quality standards

Goal 1: Reduce pathogenic bacteria from livestock (cattle) manure runoff by about 2.2 (*cfu*) on average per year for five consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Goal 2: Reduce pathogenic bacteria from failing HSTS discharge by about 0.47 *cfu* per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Rattlesnake Creek Subwatershed

14 Digit HUC: 05060001130040
Location: Rattlesnake Creek and Tributaries River Mile 50.43
Drainage Area: 22.76 square miles, 14,565 acres
Miles of Stream: 39.8
Average Sinuosity: 1.31

Concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Fluctuating surface water flows from increased underground drainage
- Log jams and drainage issues

Subwatershed Description

The Rattlesnake Creek is the fourth largest of the eight subwatersheds in the project area. The subwatershed is defined as the area of land draining into the Rattlesnake Creek watershed. This watershed drains mostly agricultural and forested land within Licking and Delaware Counties (map 4-7). Portions of this subwatershed lie within Trenton and Harlem Townships in Delaware County and Hartford and Monroe Townships in western Licking County. Although this subwatershed is in close proximity to Sunbury, there are no major incorporated areas within this subwatershed. The highest subwatershed elevation is 1,191.9 feet and the lowest elevation is 971.5 feet. Total relief is 220.4 feet.

Rattlesnake Creek begins in western Licking County. North Fork Rattlesnake Creek flows west into Delaware County for 8 miles where it joins the East Fork Rattlesnake Creek, flowing west into Delaware County for 6.6 miles, to form Rattlesnake Creek. The South Fork Rattlesnake Creek flows northwest out of Licking County into Delaware County for 7.2 miles where it joins the main stem of Rattlesnake Creek. From this point, the main stem flows west for 5 miles where it joins the Big Walnut Creek in Sunbury. There are about 13 miles of small feeder streams and ditches that are unnamed on the USGS topographic maps. Local names for these streams include Mink Run, Middle Fork Rattlesnake Creek, Dewitt Whitney Ditch, Ashbrook Joint County Ditch, and Johnson Joint County Ditch.

Close to 76 percent of the Rattlesnake Creek watershed is in agricultural production with 72 percent in row crop production and 4 percent in pastureland (table 4-31 and map 4-8). The 100-year floodplain is comprised of 21 percent agricultural production and 71 percent forested. OEPA land cover data set from 1999-2003 was used to ascertain the land use within a 100' buffer around all surface waters. Agricultural production constitutes over 49 percent of the land use within a 100 foot buffers around watershed surface waters. Forested and wetland areas encompass nearly 40 percent and residential areas about 11 percent of the 100 foot buffers (table 4-32)

Table 4-31. Rattlesnake Creek Subwatershed Land Use

Description	Acres	Percent of Watershed

Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	2,004	13.76
Pasture	621	4.27
Residential	1,505	10.34
Row Crops	10,434	71.64
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	0.00	0.00
Total	14,565	100.00

Table 4-32. Rattlesnake Creek Subwatershed Land Use Within 100' Stream Buffer

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	337	39.95
Pasture	34	3.96
Residential	94	11.17
Row Crops	379	44.92
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	0.00	0.00
Total	845	100.00

Table 4-33. Ohio Wetland Inventory Acres for Rattlesnake Creek Subwatershed

Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
36.8	24.2	21.9	2.0	519.8

Table 4-34. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Rattlesnake Creek Subwatershed. 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
40.0	4.0	11.2	44.9	0	0

Soils

The major soils are Bennington, Centerburg, and Pewamo on ground moraines and end moraines. Together these three soils comprise nearly 92 percent of the subwatershed. About 743 acres or over 5.0 percent of the subwatershed are Lobdell, Shoals, and Sloan soils which are classified as alluvial (floodplain) soils and are subject to occasional flooding. Over 6,100 acres or about 42 percent of the soils have slopes greater than 2 percent and are subject to erosion. About 5 percent of the soils are considered moderately eroded. Tables 4-35 thru 4-38 provide acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage

class. More detailed information about the soils is given in the soil surveys of Delaware and Licking counties.

Table 4-35. Hydrologic Soil Group Classification for Rattlesnake Creek Subwatershed (SSURGO)

Hydrologic Group Acres						
A/D	B	B/D	C	C/D	D	Not Rated
	293.4	582.9	10,014.8	3,532.8	130.5	10.7

Table 4-36. Hydric Soil Rating (acres) for Rattlesnake Creek Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
2,084	16	11,959	506

Table 4-37. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Rattlesnake Creek Subwatershed

Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
2,885	10,956	75 percent	209	508

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 78 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-38 lists the acreage for each drainage class for Rattlesnake Creek subwatershed.

Table 4-38. Drainage Class Acreage for Rattlesnake Creek Subwatershed

Unknown	Moderately well drained	Poorly Drained	Somewhat poorly drained	Very poorly drained	Well drained
11	3,368	33	6,716	4,213	223

Water Quality

Biological

The Rattlesnake Creek subwatershed has been given a WWH aquatic life use designation and a Primary Contact Recreation (PCR) recreational use designation. At various time during the year, Rattlesnake Creek is not meeting its PCR designation due to high levels of bacteria. There are 7.8 stream miles that are not meeting the WWH designation and 2.2 miles with partial attainment. The cause of impairments to these sections is habitat alteration, flow alteration, nutrients, siltation, ammonia, organic enrichment, suspended solids, and pathogens. An unknown source of metals was detected in Rattlesnake Creek. Possible sources for the other impairments

are channelization, septage disposal, crop production, livestock operations, residential and commercial land development, and home sewage treatment systems. These impairments have led to substandard IBI scores at four of the OEPA sampling locations (table 4-39). A fifth location was listed as having a poor score for the Modified Index of Well Being according to OEPA.

Table 4-39. OEPA Sampling Stations in Rattlesnake Creek Subwatershed

Station	River	River Mile	QHEI	IBI	ICI
S02100 50.401982	Big Walnut Creek	50.4	0	0	28
S02150 0.102000	Rattlesnake Creek	0.1	66.5	37	38
S02151 0.102000	North Fork Rattlesnake Creek	0.1	68	0	0
S02151 1.702000	North Fork Rattlesnake Creek	1.7	59.5	40	0
S02151 3.402000	North Fork Rattlesnake Creek	3.4	37.5	30	0
S02151 4.802000	North Fork Rattlesnake Creek	4.8	58.5	40	0
S02151 5.802000	North Fork Rattlesnake Creek	5.8	41	32	0
S02152 0.202000	East Fork Rattlesnake Creek	0.2	56	38	0
S02152 1.202000	East Fork Rattlesnake Creek	1.2	0	0	0
S02152 4.202000	East Fork Rattlesnake Creek	4.2	48.5	12	0
S02153 0.202000	South Fork Rattlesnake Creek	0.5	53	24	0
S02153 1.302000	South Fork Rattlesnake Creek	1.3	48.5	0	0
S02153 3.002000	South Fork Rattlesnake Creek	3	59	0	0
S02153 3.702000	South Fork Rattlesnake Creek	3.7	59.5	44	0
S02153 4.802000	South Fork Rattlesnake Creek	4.8	45	0	0

Physical

The average QHEI score for this subwatershed is 53.88 (table 4-39) which does not meet the recommended target score of 60 for the WWH aquatic life use designation. Habitat attributes that had a high influence on the QHEI scores for the North Fork and East Fork of Rattlesnake Creek were low sinuosity and sparse or no cover. Attributes that had a moderate influence on the North Fork were channelized but recovering, hardpan substrate origin, fair or poor channel, only one or two cover types, no fast current, and high to moderate substrate embeddedness. The East Fork

was similar to North Fork with attributes having a moderate influence on habitat but with more diverse cover types. The South Fork did not present any high influence attributes. Moderate influences on attribute scores included hardpan substrate origin, fair or poor channel development, no fast current, high to moderate substrate embeddedness.
This subwatershed has over 11 miles of open but unmaintained ditches which has a direct correlation to the observed QHEI scores. Although these ditches have not been maintained for quite some time the impacts of past dredging practices has had a major impact on the quality and diversity of instream and riparian habitat within the Rattlesnake Creek subwatershed.

Chemical
As in other subwatersheds, pesticide runoff continues to be a concern. Overland runoff or infiltration into subsurface drainage systems continues to be the main source for this nonpoint source pollution. Phosphorous and fecal coliform continue to be a concern in this subwatershed. Possible sources for these impairments are agricultural land use and failing home sewage treatment systems.

Ohio EPA calculated the total fecal coliform and phosphorous loads for the entire 14-digit subwatershed and listed the necessary reduction from current levels in order to meet the TMDL. Fecal coliform, expressed in colony forming units (*cfu*), was found to have an existing load of 34 and needs a 77 percent reduction to achieve the TMDL. Livestock operations or manure field applications was listed as the number one nonpoint source for fecal coliform in this subwatershed. Total phosphorous, expressed as pounds per year, had a 20,039 pounds per year load from point and nonpoint source pollution. A 72 percent reduction is needed to conform to the TMDL. Cropland, pastureland, and failing HSTS were listed as the main nonpoint sources for phosphorous in this subwatershed.

Problem Statements

Problem Statement 1:
Nearly 7 miles of stream has only fair levels of biological performance (ICI/IBI and QHEI scores not meeting WQS) caused by physical habitat degradation (channel modifications) from direct alteration of the stream channel and removal of riparian vegetation.

Goal 1: Improve in-stream physical habitat to about 7 miles of impaired stream channel to increase and maintain QHEI scores at 60 points or more.

Objective 1: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat resulting from the alteration of natural drainage.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the Ohio Drainage Report, Ohio Drainage Law (summary), and Ohio Drainage Manual (Draft III)

Action 3: Provide landowner drainage management workshops upon request and as needed for new group projects.

Action 4: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended drainage actions.

Objective 2: Establish procedure to assure that all channel management activities and practices under maintenance minimize negative QHEI score impacts.

Action 1: Score all new channel management projects prior to undertaking modifications or restorations.

Action 2: Establish review team to evaluate new project proposals and determine projected QHEI score.

Objective 3: Apply current best management strategies and practices on all new stream channel modification and existing maintenance projects.

Action 1: Adhere to all NRCS drainage maintenance specifications in the FOTG

Action 2: Develop watershed drainage evaluation service to review areas to be considered for maintenance using table format inspection form proposed in the draft Ohio Drainage Manual.

Action 3: Seek additional incentives to encourage adoption of best management practices for channel maintenance activity by exploring market-based approaches, such as water quality credit trading, and utilizing special grants.

Action 4: Require all new drainage projects be placed on permanent county maintenance

Goal 2: Increase riparian vegetation along nearly 10 miles of impaired stream to help increase and maintain QHEI scores at 60 points or more.

Objective 1: Establish 2 acres of woody riparian buffers to improve riparian physical habitat.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Provide landowners with an opportunity to attend field tours that demonstrate the benefits of riparian buffers.

Objective 2: Establish 5 new acres of herbaceous riparian buffers (filter strips) per year for 3 years.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Conduct annual riparian buffer field tour

Problem Statement 2: About 9 miles of stream has only fair levels of biological performance (ICI and QHEI) scores not meeting WQS) caused by 27,330 ton of excess sediment loading (embeddedness) from adjacent cropland. In addition, the sum of the substrate, channel, and riparian categories from the QHEI assessment at eight sites on the North Fork, East Fork, and South Fork of Rattlesnake Creek range from 0.5 to 11.0 points less than the TMDL sediment target score of ≥ 33.

Goal 2: Reduce soil erosion from unprotected cropland by about 5,470 tons per year (.52 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 445 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 445 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 5 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Install 1 grade stabilization structure to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of grade stabilization structure implementation.

Objective 6: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 3: Nearly 9 miles of stream have only fair levels of biological performance (ICI and QHEI scores not meeting WQS) caused by about 11,250 pounds per year of excess nutrient enrichment (phosphorus) from agricultural runoff and agricultural tile drainage systems.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by 2,250 pounds per year for 5 consecutive years.

Objective 1: Treat 200 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 5 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit farmers through continued and increased collaboration with the Delaware and Licking SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 3: Establish 2 acres of critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control phosphates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Problem Statement 4: About 7 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 185 pounds per year of excess nutrient enrichment (phosphorus) from livestock (cattle) access to streams.

Goal: Reduce phosphate loading due to livestock manure directly entering streams by an average of about 37 pounds per year for 5 consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments
Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures
Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Problem Statement 5: About 7 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 1,490 pounds per year of excess nutrient enrichment (phosphorus) from failing household sewage treatment systems.

Goal: Reduce phosphorus loading from failing on-site HSTS discharge by about 1,490 pounds per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.
Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.
Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.
Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.
Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems
Action 1: Implement repair or replacement procedures to bring systems into compliance.
Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.
Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.
Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 6: About 2 miles of stream has only fair levels of biological performance (ICI and QHEI scores not meeting WQS) caused by about 34 ton of excess nutrient enrichment (nitrates) from cropland runoff and agricultural tile drainage systems.

Goal 1: Reduce nitrate loading from agricultural cropland runoff by 10 percent or about 1.76 pounds per acre per year for 5 consecutive years.

Objective: Treat approximately 3,800 cropland acres per year with nitrate reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Design, print and distribute one fact sheet describing practices offered and economic and environmental benefits.

Action 2: Target outreach (specifically a fact sheet) and quality technical assistance to generate higher levels of nitrate reduction implementation.

Action 3: Train agriculture professionals (Certified Crop Advisors) in EQIP Management Systems approach, program availability and benefits

Action 4: Engage farmers to enroll fields

Action 5: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 6: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Goal 2: Reduce nitrate loading from agricultural cropland tile drainage systems by about 5 pounds per acre per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control phosphates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Action 3: Host field day with partners to discuss practices offered

Goal 3: Improve nitrate use efficiency by 25-40 pounds per acre per year on average.

Objective 1: Engage producers to implement adaptive management approach to nutrient management.

Action 1: Involve farmers in nutrient efficiency network to advance adaptive management approach to nitrate management and increase accountability and validation of impact.

Action 2: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Problem Statement 7: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 31 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 2: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 2: Report concerns to UBWC WQ Partnership

Goal 3: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average

Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 8: About 7 miles of stream have only fair levels of biological performance (IBI/ICI scores not meeting WQS) caused by organic enrichment (low DO) from numerous (unspecified) sources of oxidizable material.

Goal: Reduce nutrient loading from numerous unspecified sources to increase and maintain dissolved oxygen levels to 5.0 mg/l average over a 24 hour period and 4.0 mg/l instantaneous minimum.

Objective 1: Establish 15 new acres of filter strips per year to trap or control nutrients

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit landowners through continued and increased collaboration with the Delaware, Knox, and Morrow SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Problem Statement 9: About 9 miles of stream are not meeting the primary contact recreational use designation caused by the presence of about 26 colony forming units (*cfu*) per year of excess pathogen loading (fecal coliform and *E. coli*) from livestock manure runoff and failing home sewage treatment systems (HSTS).

Goal 1: Reduce pathogenic bacteria from livestock (cattle) manure runoff by about 5.2 (*cfu*) on average per year for five consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Goal 2: Reduce pathogenic bacteria from failing HSTS discharge by about 0.39 *cfu* per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Prairie Run Subwatershed

14 Digit HUC: 05060001130050
Location: Below Rattlesnake Creek and Above Little Walnut Creek RM 48.6
Drainage Area: 8.60 square miles, 5,506 acres
Miles of Stream: 18.8
Average Sinuosity: 1.10

Concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Increase in urban stormwater runoff
- Monitoring downstream of development projects
- Fluctuating surface water flows from increased underground drainage

Watershed Description

Prairie Run is the smallest of the eight subwatersheds in the project area. This subwatershed is defined as the area of land draining into the Big Walnut Creek watershed between the Rattlesnake Creek subwatershed and the Little Walnut Creek subwatershed. The subwatershed drains mostly agricultural and forested land in Delaware County covering portions of Porter, Kingston, Trenton, and Berkshire Townships (map 4-9). The majority of the villages of Sunbury and Galena are included in the watershed. The highest subwatershed elevation is 1,076.4 feet and the lowest elevation is 875 feet. Total relief is 201.4 feet.

Prairie Run begins in Porter Township and flows south through the watershed for 3.6 miles before joining Little Walnut Creek. Prairie Run is the longest named stream in the subwatershed with a length of 4.85 miles. Prairie Run is heavily channelization with most of the stream categorized by Delaware SWCD as an open, unmaintained, drainage type. Koepple Ditch is a locally named drainage channel. There are other unnamed tributaries in this subwatershed which feed into Prairie Run and Big Walnut Creek.

Land use in this subwatershed is similar to the other 14-digit HUC watersheds in that agricultural production dominates with 53 percent of the land use with nearly all acreage in row crop production (table 4-40 and map 4-10). The 100-year floodplain is comprised of 13 percent agricultural production and 72 percent forested. Agricultural production constitutes 39 percent of the land use within the 100 foot buffers around subwatershed surface waters. Forested and wetland areas encompass 35 percent while residential areas cover 25 percent of the 100 foot buffers (table 4-41). Approximately 6 percent of the watershed has been developed.

Table 4-40. Prairie Run Subwatershed Land Use

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	37	0.68
Coniferous Forest	0.00	0.00
Deciduous Forest	1,268	23.03

Pasture	0.00	0.00
Residential	1,243	22.57
Row Crops	2,904	52.75
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	53	0.97
Total	5,506	100.00

Table 4-41. Prairie Run Subwatershed Land Use Within 100' Stream Buffer

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.22	0.05
Coniferous Forest	0.00	0.00
Deciduous Forest	142	35.21
Pasture	0.00	0.00
Residential	101	25.06
Row Crops	157	38.89
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	3	0.79
Total	404	100.00

Table 4-42. Ohio Wetland Inventory Acres for Prairie Run Subwatershed

Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
4.3	31.6	27.4	6.3	216.7

Table 4-43. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Prairie Run Subwatershed. 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
35.2	0	25.1	38.9	0	0.8

Soils

The major soils are Bennington, Cardington, and Pewamo on ground moraines and end moraines. Together these three soils comprise over 78 percent of the soils in the subwatershed. Nearly 345 acres or about 6.4 percent of the subwatershed are Lobdell and Sloan soils which are classified as alluvial (floodplain) soils and are subject to occasional flooding. Over 2,800 acres or about 54 percent of the soils have slopes greater than 2 percent and are subject to erosion. Nearly 6 percent of the soils are considered moderately eroded. Tables 4-44 thru 4-47 provide acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils are given in the *Soil Survey of Delaware County, Ohio*

Table 4-44. Hydrologic Soil Group Classification for Prairie Run Subwatershed (SSURGO)

Hydrologic Group Acres						
A/D	B	B/D	C	C/D	D	Not Rated
	334.1	139.6	3,561.8	1,168.8	13.6	287.7

Table 4-45. Hydric Soil Rating (acres) for Prairie Run Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
0	0	5,005	500

Table 4-46. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Prairie Run Subwatershed

Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
2,053	2,817	57 percent	n/a	635

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 68 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-47 lists the acreage for each drainage class for Prairie Run subwatershed.

Table 4-47. Drainage Class Acreage for Prairie Run Subwatershed

Unknown	Moderately well drained	Poorly Drained	Somewhat poorly drained	Very poorly drained	Well drained
288	2,232	0	1,496	1,322	168

Water Quality

Biological

The Prairie Run subwatershed has been given a WWH aquatic life use designation. Prairie Run is the only surface water in the entire project area with a Secondary Contact Recreation (wading use only) recreational designation and is currently attaining this designation. There are 0.5 stream miles between RM 0-3.6 on Prairie Run that are in partial attainment of the WWH use designation. The cause of impairments to these sections is habitat alteration, siltation, and pathogens. Channelization and urban runoff are the leading sources for these impairments. The ICI score at the monitoring site on Reynolds Run was acceptable for the ecoregion, however, the IBI score measured fair, leading to the partial attainment for this reach.

Physical

The QHEI score at the Prairie Run sampling site was 51.0 which does not meet the recommended score of 60 for the WWH aquatic life use designation. Habitat attributes that had a

high influence on the QHEI scores were low sinuosity and sparse or no cover. Moderate influences on attribute scores include the channelized, but recovering stream, hardpan substrate origin, fair or poor channel development, no fast current, high to moderate substrate embeddedness, extensive to moderate riffle embeddedness.
This subwatershed has over 3.14 miles of open but unmaintained ditches and .244 miles of maintained ditches which has a direct correlation to the observed QHEI scores. Although most of these ditches are no longer maintained, the impacts of past dredging practices have had a major impact on the quality and diversity of instream and riparian habitat.

Chemical
As in other subwatersheds, pesticide runoff continues to be a concern. Overland runoff or infiltration into subsurface drainage systems continues to be the main source for this nonpoint source pollution. Phosphorous and fecal coliform continue to be a concern in this subwatershed. Possible sources for these impairments are agricultural land use and failing home sewage treatment systems.

Ohio EPA calculated the total fecal coliform and phosphorous loads for the entire 14-digit subwatershed and listed the necessary reduction from current levels in order to meet the TMDL. Fecal coliform, expressed in colony forming units (*cfu*), was found to have an existing load of 12.3 and needs a 68 percent reduction to achieve the TMDL. Livestock operations or manure field applications was listed as the number one nonpoint source for fecal coliform in this subwatershed. Total phosphorous, expressed as pounds per year, had a 10,959 pounds per year load. A 44 percent reduction is needed to conform to the TMDL. Point source pollution from the Village of Sunbury WWTP contributes 3,850 lbs/year. Nonpoint sources contributing to the phosphorous loading are cropland, pastureland, and failing HSTS.

Problem Statements

Problem Statement 1:
About 0.5 miles of stream has only fair levels of biological performance (ICI/IBI and QHEI scores not meeting WQS) caused by physical habitat degradation (channel modifications) from direct alteration of the stream channel and removal of riparian vegetation.

Goal 1: Improve in-stream physical habitat to about 25 miles of impaired stream channel to increase and maintain QHEI scores at 60 points or more.

Objective 1: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat resulting from the alteration of natural drainage.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the Ohio Drainage Report, Ohio Drainage Law (summary), and Ohio Drainage Manual (Draft III)

Action 3: Provide landowner drainage management workshops upon request and as needed for new group projects.

Action 4: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended drainage actions.

Objective 2: Establish procedure to assure that all channel management activities and practices under maintenance minimize negative QHEI score impacts.

Action 1: Score all new channel management projects prior to undertaking modifications or restorations.

Action 2: Establish review team to evaluate new project proposals and determine projected QHEI score.

Objective 3: Apply current best management strategies and practices on all new stream channel modification and existing maintenance projects.

Action 1: Adhere to all NRCS drainage maintenance specifications in the FOTG

Action 2: Develop watershed drainage evaluation service to review areas to be considered for maintenance using table format inspection form proposed in the draft Ohio Drainage Manual.

Action 3: 6131 over WDP

Action 4: Seek additional incentives to encourage adoption of best management practices for channel maintenance activity by exploring market-based approaches, such as water quality credit trading, and utilizing special grants.

Action 5: Require all new drainage projects be placed on permanent county maintenance

Goal 2: Increase riparian vegetation along nearly 10 miles of impaired stream to help increase and maintain QHEI scores at 60 points or more.

Objective 1: Establish 2 acres of woody riparian buffers to improve riparian physical habitat.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2:

Objective 2: Establish 5 new acres of herbaceous riparian buffers (filter strips) per year for 3 years.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Conduct annual riparian buffer field tour

Problem Statement 2: About 0.5 miles of stream has only fair levels of biological performance (ICI and QHEI) scores not meeting WQS) caused by 3,250 ton of excess sediment loading (embeddedness) from adjacent cropland. In addition, the sum of the substrate, channel, and riparian categories from the QHEI assessment at RM 0.7 on Prairie Run is 25.5 which is 7.5 points less than the TMDL sediment target score of ≥ 33.

Goal: Reduce soil erosion from unprotected cropland by about 650 tons per year (.22 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 125 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 125 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 5 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Install 1 grade stabilization structures to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of grade stabilization structure implementation.

Objective 6: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 3: About 18.8 miles of stream requires about a 70 percent reduction (2,900 pounds) in total phosphorus from cropland to meet its TMDL allocation even though it is in partial attainment for aquatic life, primary contact recreational uses, and has IBI and ICI scores meeting water quality standards.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by about 580 pounds per year for 5 consecutive years.

Objective 1: Treat 580 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.
Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 5 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes
Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.
Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.
Action 4: Recruit farmers through continued and increased collaboration with the Delaware and Licking SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.
Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.
Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.
Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 3: Establish 2 acres of critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Assess the subwatershed to determine areas of highest priority.
Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control phosphates.

Action 1: Assess the subwatershed to determine areas of highest priority.
Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Problem Statement 4: About 18.8 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 65 pounds per year of excess nutrient enrichment (phosphorus) from livestock (cattle) access to streams.

Goal: Reduce phosphate loading due to livestock manure directly entering streams by an average of about 13 pounds per year for 5 consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental

impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Problem Statement 5: About 18.8 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 1,830 pounds per year of excess nutrient enrichment (phosphorus) from failing household sewage treatment systems.

Goal: Reduce phosphorus loading from failing on-site HSTS discharge by about 1,830 pounds per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 6: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 9 pounds of atrazine pesticide per year to the

mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 2: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 2: Report concerns to UBWC WQ Partnership

Goal 3: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average

Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 7: About 0.5 miles of stream are not meeting the primary contact recreational use designation caused by the presence of about 10 colony forming units (*cfu*) per year of excess pathogen loading (fecal coliform and *E. coli*) from livestock manure runoff and failing home sewage treatment systems (HSTS).

Goal 1: Reduce pathogenic bacteria from livestock (cattle) manure runoff by nearly 2 (*cfu*) on average per year for five consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Goal 2: Reduce pathogenic bacteria from failing HSTS discharge by about 0.41 *cfu* per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Little Walnut Creek Subwatershed

14 Digit HUC: 05060001130060
Location: Little Walnut Creek and Tributaries RM 48.60
Drainage Area: 32.73 square miles, 20,946 acres
Miles of Stream: 86.2
Average Sinuosity: 1.20

Concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Increase in urban runoff and stormwater volumes
- Monitoring downstream of development projects
- Fluctuating surface water flows from increased underground drainage

Watershed Description

Little Walnut Creek is the second largest of the eight subwatersheds in the project area. This subwatershed is defined as the area of land draining into the Little Walnut Creek subwatershed. This subwatershed drains mostly agricultural and forested land in Kingston and Berkshire Townships in Delaware County and a very small area of Peru Township in Morrow County (map 4-11). The highest subwatershed elevation is 1,174.9 feet and the lowest elevation is 889.4 feet. Total relief is 285.5 feet.

Little Walnut Creek begins in northern Delaware County and flows south through the watershed for 13.9 miles until it empties into Hoover Reservoir. The West Branch of Little Walnut Creek flows south from the northern portions of Kingston Township for 6.6 miles where it joins the main stem. The East Branch of the Little Walnut Creek begins just east of SR61 in southeast Kingston Township and flows west for 3.4 miles where it meets the main stem. Butler Run originates west of the Little Walnut Creek mainstem and enters slightly south of SR521. There are other locally named tributaries in this subwatershed which feed into the main stem, Butler Run, East Branch, and West Branch of Little Walnut Creek. Local names include Butler Run Ditch, Pumphrey Ditch, Ribov Ditch, Weiant Ditch, Ton Branch, Spring Run, and Taylor Run

Land use in this subwatershed is similar to the other 14-digit HUC watersheds in that agricultural production dominates with over 54 percent of the land use with 49 percent in row crop production and 3 percent in pastureland (table 4-48 and map 4-12). Just over 10 percent of the 100-year floodplain is in agricultural production with 78 percent of the floodplain being forested. Row crop production constitutes 39 percent and pastureland 3 percent of the land use within the 100 foot buffers around watershed surface waters. Forested and wetland areas encompass 44 percent and residential areas 11 percent of the 100 foot buffers (table 4-49).

Table 4-48. Little Walnut Creek Subwatershed Land Use

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	327	1.56
Coniferous Forest	0.00	0.00

Deciduous Forest	6,373	30.43
Pasture	1,100	5.25
Residential	2,470	11.79
Row Crops	10,295	49.15
Urban/Recreational Grasses	372	1.78
Woody Wetlands	0.00	0.00
Water	9	0.04
Total	20,946	100.00

Table 4-49. Little Walnut Creek Land Use Within 100' Stream Buffer

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	821	44.45
Pasture	58	3.14
Residential	198	10.72
Row Crops	727	39.34
Urban/Recreational Grasses	43	2.35
Woody Wetlands	0.00	0.00
Water	0.00	0.00
Total	1,848	100.00

Table 4-50. Ohio Wetland Inventory Acres for Little Walnut Creek Subwatershed

Farmed wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet woods
25.1	56.6	44.4	2.0	807.5

Table 4-51. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Little Walnut Creek Subwatershed. 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody wetlands	Water
44.5	3.1	13.1	39.3	0	0

Soils

The major soils are Bennington, Cardington, and Pewamo on ground moraines and end moraines. Together these three soils comprise over 86 percent of the soils in the subwatershed. Nearly 1,155 acres or about 5.6 percent of the subwatershed are Lobdell and Sloan soils which are classified as alluvial (floodplain) soils and are subject to occasional flooding. Over 11,300 acres or about 55 percent of the soils have slopes greater than 2 percent and are subject to erosion. About 10 percent of the soils are considered moderately eroded. Tables 4-52 thru 4-55 provide acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils is given in the soil surveys of Delaware and Morrow counties.

Table 4-52. Hydrologic Soil Group Classification for Little Walnut Creek Subwatershed (SSURGO)

Hydrologic Group Acres						
A/D	B	B/D	C	C/D	D	Not Rated
	422.4	1,216.4	16,003.2	2,822.2	105.4	376.0

Table 4-53. Hydric Soil Rating (acres) for Little Walnut Creek Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
0	0	18,462	2,484

Table 4-54. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Little Walnut Creek Subwatershed

Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
6,389	11,903	65 percent	n/a	2,656

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 66 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-55 lists the acreage for each drainage class for Little Walnut Creek subwatershed.

Table 4-55. Drainage Class Acreage for Little Walnut Creek Subwatershed

Unknown	Moderately well drained	Poorly Drained	Somewhat poorly drained	Very poorly drained	Well drained
376	7,826	0	7,759	4,143	839

Water Quality

Biological

The Little Walnut Creek subwatershed has been given a WWH aquatic life use designation and a Primary Contact Recreation (PCR) designation. The Little Walnut Creek has a total of 6.05 stream miles that are in non-attainment of the WWH use designation and 3.85 miles in full attainment. The main cause of impairment is listed as flow alteration with the source being dam construction. Butler Run has 1.0 miles of stream in non-attainment of the WWH use designation with habitat alteration, siltation, organic enrichment, and pathogens listed as the causes of impairment to this reach. Channelization, nonirrigated crop production, loss of riparian vegetation, and range land activities are listed as the sources of impairment to Butler Run. The West Branch of Little Walnut Creek has a total of 3.8 miles not meeting the WWH requirement. Organic enrichment, ammonia, nutrients and pathogens are listed as the cause of impairment.

Failing home sewage treatment systems and agriculture are listed as the sources of impairment to the West Branch. The East Branch had 0.9 miles in full attainment of WWH. One unnamed tributary to Little Walnut Creek at RM 9.5 had 1.0 miles of stream in full attainment. The IBI and ICI scores at the third monitoring site on Little Walnut Creek had a significant departure from the ecoregion biocriterion which led to its non-attainment status. The monitoring sites on the West Branch of Little Walnut Creek and Butler Run also had sub-standard IBI and ICI scores leading to their non-attainment status. More monitoring sites need to be identified for this subwatershed to pinpoint nonpoint causes and sources of impairment.

Physical
The OEPA has seven monitoring sites located within this subwatershed, three on the Little Walnut Creek, one on a unnamed tributary to Little Walnut Creek, Butler Run, East Branch of Little Walnut Creek, and West Branch of Little Walnut Creek. The QHEI scores on the Little Walnut Creek sites, including the unnamed tributary, are 66.5, 62, and 68. All three scored above the threshold for the WWH use designation. The Butler Run monitoring site scored a 45 which falls below the recommended score of 60 for the WWH aquatic life use designation. The East Branch site scored a 73 which is well above the WWH threshold of 60. The following habitat attributes had a high influence on the QHEI scores that did not meet the required score of 60 to meet the WWH use designation: channelized with no recovery, low sinuosity, and sparse or no cover. Moderate influences on attribute scores include channelized, but recovering, hardpan substrate origin, fair or poor channel development, no fast current, high to moderate substrate embeddedness, extensive to moderate riffle embeddedness. This subwatershed has over 12 miles of open but unmaintained ditches and 1.1 miles of maintained ditches. Channelization has a direct correlation to instream and riparian habitat conditions. The observed QHEI scores reflect this. Although most of these ditches are no longer maintained, the impacts of past dredging practices have had a major impact on the quality and diversity of instream and riparian habitat.

Chemical
As in other subwatersheds, pesticide runoff continues to be a concern. Over the land runoff or infiltration into subsurface drainage systems continues to be the main source for this nonpoint source pollution. Phosphorous and fecal coliform continue to be a concern in this subwatershed. Possible sources for these impairments are agricultural land use and failing home sewage treatment systems.

Ohio EPA calculated the total fecal coliform and phosphorous loads for the entire 14-digit subwatershed and listed the necessary reduction from current levels in order to meet the TMDL. Fecal coliform, expressed in colony forming units (*cfu*), was found to have an existing load of 49 and needs a 78 percent reduction to achieve the TMDL. Livestock operations or manure field applications was listed as the number one nonpoint source for fecal coliform in this subwatershed. Total phosphorous, expressed as pounds per year, had a 25,135 pounds per year load. A 69 percent reduction is needed to conform to the TMDL. Nonpoint sources contributing to the phosphorous loading are cropland, pasture land, and failing HSTS.

Problem Statements

Problem Statement 1:

About 1.0 miles of stream has only fair levels of biological performance (IBI/ICI and QHEI scores not meeting WQS) caused by physical habitat degradation (channel modifications) from direct alteration of the stream channel and removal of riparian vegetation.

Goal 1: Improve in-stream physical habitat to about 25 miles of impaired stream channel to increase and maintain QHEI scores at 60 points or more.

Objective 1: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat resulting from the alteration of natural drainage.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the Ohio Drainage Report, Ohio Drainage Law (summary), and Ohio Drainage Manual (Draft III)

Action 3: Provide landowner drainage management workshops upon request and as needed for new group projects.

Action 4: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended drainage actions.

Objective 2: Establish procedure to assure that all channel management activities and practices under maintenance minimize negative QHEI score impacts.

Action 1: Score all new channel management projects prior to undertaking modifications or restorations.

Action 2: Establish review team to evaluate new project proposals and determine projected QHEI score.

Objective 3: Apply current best management strategies and practices on all new stream channel modification and existing maintenance projects.

Action 1: Adhere to all NRCS drainage maintenance specifications in the FOTG

Action 2: Develop watershed drainage evaluation service to review areas to be considered for maintenance using table format inspection form proposed in the draft Ohio Drainage Manual.

Action 3: 6131 over WDP

Action 4: Seek additional incentives to encourage adoption of best management practices for channel maintenance activity by exploring market-based approaches, such as water quality credit trading, and utilizing special grants.

Action 5: Require all new drainage projects be placed on permanent county maintenance

Goal 2: Increase riparian vegetation along nearly 10 miles of impaired stream to help increase and maintain QHEI scores at 60 points or more.

Objective 1: Establish 2 acres of woody riparian buffers to improve riparian physical habitat.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Provide landowners with an opportunity to attend field tours that demonstrate the benefits of riparian buffers.

Objective 2: Establish 5 new acres of herbaceous riparian buffers (filter strips) per year for 3 years.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Provide landowners with an opportunity to attend field tours that demonstrate the benefits of riparian buffers.

Problem Statement 2: About 1.0 mile of stream has only fair levels of biological performance (ICI and QHEI) scores not meeting WQS) caused by about 11,530 ton of excess sediment loading (embeddedness) from adjacent cropland. In addition, the sum of the substrate, channel, and riparian categories from the QHEI assessment at RM 1.2 on Butler Run is 25.0 which is 8 points less than the TMDL sediment target score of ≥ 33.

Goal: Reduce soil erosion from unprotected cropland by about 2,300 tons per year (.22 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 440 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 440 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 5 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Install 1 grade stabilization structures to trap sediments before entering the stream.

Action: Target outreach and quality technical assistance to generate higher levels of grade stabilization structure implementation.

Objective 6: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.
Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.
Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 3: Nearly 4 miles of stream have only fair levels of biological performance (ICI and QHEI scores not meeting WQS) caused by about 12,300 pounds per year of excess nutrient enrichment (phosphorus) from agricultural runoff and agricultural tile drainage systems.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by about 2,460 pounds per year for 5 consecutive years.

Objective 1: Treat 10,250 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.
Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.
Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 5 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes
Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.
Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.
Action 4: Recruit farmers through continued and increased collaboration with the Delaware and Licking SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.
Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.
Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.
Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 3: Establish 2 acres of critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Assess the subwatershed to determine areas of highest priority.
Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control phosphates.

Action 1: Assess the subwatershed to determine areas of highest priority.
Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Problem Statement 4: About 4 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 250 pounds per year of excess nutrient enrichment (phosphorus) from livestock (cattle) access to streams.

Goal: Reduce phosphate loading due to livestock manure directly entering streams by an average of about 50 pounds per year for 5 consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments
Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures
Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Problem Statement 5: About 4 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 2,460 pounds per year of excess nutrient enrichment (phosphorus) from failing home sewage treatment systems.

Goal: Reduce phosphorus loading from failing on-site HSTS discharge by about 2,460 pounds per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.
Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.
Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 6: Nearly 4 miles of stream have only fair levels of biological performance (IBI/ICI and QHEI scores not meeting WQS) caused by about 32 ton of excess nutrient enrichment (nitrates) from cropland runoff and agricultural tile drainage systems.

Goal 1: Reduce nitrate loading from agricultural cropland runoff by 10 percent or about 1.76 pounds per acre per year for 5 consecutive years.

Objective: Treat approximately 3,600 cropland acres per year with nitrate reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Design, print and distribute one fact sheet describing practices offered and economic and environmental benefits.

Action 2: Target outreach (specifically a fact sheet) and quality technical assistance to generate higher levels of nitrate reduction implementation.

Action 3: Train agriculture professionals (Certified Crop Advisors) in EQIP Management Systems approach, program availability and benefits

Action 4: Engage farmers to enroll fields

Action 5: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 6: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Goal 2: Reduce nitrate loading from agricultural cropland tile drainage systems by about 5 pounds per acre per year.

Objective 1: Install one (1) denitrifying bioreactor to trap nitrates

Action 1: Assess site suitability

Action 2: Contact eligible landowners in high priority areas to determine willingness to install practice.

Action 3. Install bioreactor

Objective 2: Install one (1) structure for water control and drainage water management practices to control nitrates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact eligible landowners in high priority areas to determine willingness to install practice.

Action 3: Install water control structure

Goal 3: Improve nitrate use efficiency by 25-40 pounds per acre per year on average.

Objective 1: Engage producers to implement adaptive management approach to nutrient management.

Action 1: Involve farmers in nutrient efficiency network to advance adaptive management approach to nitrate management and increase accountability and validation of impact.

Action 2: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Problem Statement 7: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 31 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 2: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 2: Report concerns to UBWC WQ Partnership

Goal 3: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average

Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 8: About 5.0 miles of stream have only fair levels of biological performance (IBI/ICI scores not meeting WQS) caused by organic enrichment (low DO) from numerous (unspecified) sources of oxidizable material.

Goal 1: Reduce nutrient loading from numerous unspecified sources to increase and maintain dissolved oxygen levels to 5.0 mg/l average over a 24 hour period and 4.0 mg/l instantaneous minimum.

Objective 1: Establish 15 new acres of filter strips per year to trap or control nutrients

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit landowners through continued and increased collaboration with the Delaware, Knox, and Morrow SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Goal 2: Increase riparian vegetation along 15 miles of impaired stream per year to increase and maintain dissolved oxygen levels to 5.0 mg/l average over a 24 hour period and 4.0 mg/l instantaneous minimum.

Objective 1: Develop wooded riparian zones by constructing 0.5 miles of one-sided ditch maintenance practices with setbacks for maintenance.

Action 1: Seek funding to compensate landowners for loss of land on one-side or two stage drainage projects.

Action 2: Place new drainage projects on permanent county maintenance

Problem Statement 9: About 4 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by ammonia from failing home sewage treatment systems (HSTS).

Goal: Reduce ammonia discharge from failing HSTS.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Problem Statement 10: About 5 miles of stream are not meeting the primary contact recreational use designation caused by the presence of about 38 colony forming units (*cfu*) per year of excess pathogen loading (fecal coliform and *E. coli*) from livestock manure runoff and possibly failing home sewage treatment systems (HSTS).

Goal 1: Reduce pathogenic bacteria from livestock (cattle) manure runoff by about 7.5 (*cfu*) on average per year for five consecutive years.

Objective: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat and water quality resulting from direct access to streams by livestock.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the EQIP brochure providing financial incentives for livestock exclusion fencing and alternative watering structures

Action 3: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended grazing and livestock watering practices.

Goal 2: Reduce pathogenic bacteria from failing HSTS discharge by about 0.65 *cfu* per year.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

Hoover Reservoir Subwatershed
14 Digit HUC: 05060001130070
Location: Below Little Walnut Creek and above Hoover Dam RM 41.00
Drainage Area: 29.75 square miles, 19,039 acres
Miles of Stream: 43.3
Average Sinuosity: 1.22

Concerns from local communities:

- Lack of overall community knowledge of watershed related issues
- Increase in urban runoff and stormwater
- Access to natural areas
- Fluctuating surface water flows from increased underground drainage

Subwatershed Description

The Hoover Reservoir Area is the third largest of the eight subwatersheds in the project area. This subwatershed is defined as the area of land draining into the Hoover Reservoir downstream from Little Walnut Creek and upstream from the Hoover Dam. The subwatershed drains mostly agricultural and forested land in southeastern Delaware County. The majority of the subwatershed lies within Genoa and Harlem Townships in Delaware County with a small portion in northern Franklin County (map 4-13). The highest subwatershed elevation is 1,104 feet and the lowest elevation is 843.8 feet. Total relief is 260.2 feet.

The subwatershed includes Hoover Reservoir and small feeder streams leading to the impoundment. None of the small streams are named on the USGS topographic maps but local names include Curtis Run, Rupp Ditch, North Branch Spruce Run, South Branch Spruce Run, Adams Ditch, Sulphur Run, Lewis Ditch, Brookview Ditch, and Ferris Ditch. Hoover Reservoir is a source of drinking water for the City of Columbus and services about 800,000 residents. The volume of at 890 feet elevation is about 19.7 billion gallons with about 2,825 surface water acres. The volume of water and surface area may be increased significantly with the addition of the crestgates. The City of Columbus owns approximately 1,780 acres of land adjacent to the reservoir. The buffered land area is considerably smaller when compared to other source water reservoirs in Delaware County and the area adjacent to this land is rapidly developing.

Land use in this subwatershed is quite different than the other 14-digit HUC watersheds in that open water accounts for nearly 13 percent of the land use with agricultural production accounting for just over 34 percent. Development areas constitute over 13 percent of the land use with forested lands accounting for over 34 percent (table 4-56 and map 4-14). Forest land use composes 22 percent of the land cover within the 100-year floodplain followed by 69 percent open water, and 5 percent agriculture. When examining the 100' buffers around all surface waters, forested and wetland areas dominate with 61 percent of the land use. Row crop production encompasses 2 percent with residential areas covering just under 7 percent of the land within the 100 foot stream buffers (table 4-57).

Table 4-56. Hoover Reservoir Subwatershed Land Use

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	43	0.23
Deciduous Forest	6,532	34.31
Pasture	0.00	0.00
Residential	2,535	13.31
Row Crops	6,501	34.15
Urban/Recreational Grasses	979	5.14
Woody Wetlands	0.00	0.00
Water	2,448	12.86
Total	19,039	100.00

Table 4-57. Hoover Reservoir Subwatershed Land Use Within 100' Stream Buffers

Description	Acres	Percent of Watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	635	60.97
Pasture	0.00	0.00
Residential	69	6.62
Row Crops	204	19.56
Urban/Recreational Grasses	37	3.56
Woody Wetlands	0.00	0.00
Water	97	9.29
Total	1,042	100.00

Table 4-58. Ohio Wetland Inventory Acres for Hoover Reservoir Subwatershed

Farmed Wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet Woods
21.4	123.3	61.3	3.8	769.2

Table 4-59. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Hoover Reservoir Subwatershed. 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row Crops	Woody Wetlands	Water
61.0	0	23.1	19.6	0	9.3

Soils

The major soils are Bennington, Centerburg, and Pewamo on ground moraines and end moraines. Together these three soils comprise over 70 percent of the soils in the subwatershed. About 130 acres or nearly 0.8 percent of the subwatershed are Lobdell and Sloan soils which are classified as alluvial (floodplain) soils and are subject to occasional flooding. Over 6,100 acres or about 38 percent of the soils have slopes greater than 2 percent and are subject to erosion. Nearly 5 percent of the soils are considered moderately eroded. Tables 4-60 thru 4-63 provide

acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils is given in the soil surveys of Delaware and Franklin counties.

Table 4-60. Hydrologic Soil Group Classification for Hoover Reservoir Subwatershed (SSURGO)

Hydrologic Group Acres						
A/D	B	B/D	C	C/D	D	Not Rated
	82.8	201.6	11,028.9	3,984.3	358.0	3,383.1

Table 4-61. Hydric Soil Rating (acres) for Hoover Reservoir Subwatershed

All Hydric	Not Hydric	Partially Hydric	Unknown
0	0	13,850	5,189

Table 4-62. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Hoover Reservoir Subwatershed

Prime farmland Acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
2,243	12,095	72 percent	n/a	4,700

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Approximately 90 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-63 lists the acreage for each drainage class for Hoover Reservoir subwatershed.

Table 4-63. Drainage Class Acreage for Hoover Reservoir Subwatershed

Unknown	Moderately well drained	Poorly drained	Somewhat poorly drained	Very poorly drained	Well drained
3,383	2,588	153	7,611	4,331	973

Water Quality

Biological

This subwatershed has been given a WWH aquatic life use designation and a Primary Contact Recreation (PCR) designation. Ohio EPA does not conduct IBI or ICI surveys within lake or reservoir environments. There is a need to develop monitoring sites within this subwatershed.

Chemical

Hoover Reservoir is the depository for all nonpoint and point source pollutants in the watershed. In the past, pesticide runoff was the main concern and sparked most of the current work that has

been accomplished throughout the UBWC watershed. However, nutrients, pathogens, and sediments are also concerns within the reservoir.

Problem Statements

Problem Statement 1:
Nearly 16 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by physical habitat degradation (channel modifications) from direct alteration of the stream channel and removal of riparian vegetation.

Goal 1: Improve in-stream physical habitat to 16 miles of impaired stream channel to increase and maintain QHEI scores at 60 points or more.

Objective 1: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat resulting from the alteration of natural drainage.

Action 1: Develop contact list for landowners adjacent to impaired stream channel segments

Action 2: Make available to all owners of land adjacent to impaired stream segments copies of Ohio Drainage Report, Ohio Drainage Law (summary), and Ohio Drainage Manual (Draft III)

Action 3: Provide landowner drainage management workshops upon request and as needed for new group projects.

Action 4: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended drainage actions

Action:

Objective 2: Establish procedure to assure that all channel management activities and practices under maintenance minimize negative QHEI score impacts.

Action 1: Score all new channel management projects prior to undertaking modifications or restorations.

Action 2: Establish review team to evaluate new project proposals and determine projected QHEI score.

Objective 3: Apply current best management strategies and practices on all new stream channel modification and existing maintenance projects.

Action 1: Adhere to all NRCS drainage maintenance specifications in FOTG

Action 2: Develop watershed drainage evaluation service to review areas to be considered for maintenance using table format inspection form proposed in the draft Ohio Drainage Manual.

Action 3: 6131 over WDP

Action 4: Seek additional incentives to encourage adoption of best management practices for channel maintenance activity by exploring market-based approaches, such as water quality credit trading, and utilizing special grants.

Action 5: Require all new drainage projects be placed on permanent county maintenance

Goal 2: Increase riparian vegetation along 16 miles of impaired stream to help increase and maintain QHEI scores at 60 points or more.

Objective: Establish 15 new acres of herbaceous riparian buffers (filter strips) per year for 3 years.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Conduct annual riparian buffer field tour

Problem Statement 2: 2 miles of stream have only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by flow alteration from channel modifications (direct alteration of the stream channel) and agricultural tile drainage systems (dewatering).

Goal: Improve stream flow dynamics (highs lower and lows higher) from dewatering by unmanaged agricultural drainage systems by 1 percent

Objective 1: Install 3 drainage water management practices per year to "directly manipulate (control)" drainage discharge and retention on waters impaired by agricultural tile drainage dewatering.

Action 1: Host field day with partners to discuss practices offered and their environmental benefits.

Action 2: Target one direct mailing to producers per year.

Problem Statement 3: About 43.3 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by 7,280 ton of excess sediment loading (embeddedness) from adjacent cropland.

Goal 2: Reduce soil erosion from unprotected cropland by about 1,460 tons per year (.23 ton per acre per year) for 5 consecutive years.

Objective 1: Establish 3,300 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 280 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 15 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Install 1 grade stabilization structures to trap sediments before entering the stream.

Action: Target outreach and quality technical assistance to generate higher levels of grade stabilization structure implementation.

Objective 6: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 4: About 16 miles of stream has only fair levels of biological performance (IBI/ICI/QHEI scores not meeting WQS) caused by about 6,500 pounds per year of excess nutrient enrichment (phosphorus) from agricultural runoff and agricultural tile drainage systems.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by 1,600 pounds per year for 4 consecutive years.

Objective 1: Treat 3,300 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 15 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit farmers through continued and increased collaboration with the Delaware, Knox, and Morrow SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.
Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 4: Establish 2 critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Contact eligible landowners
Action 2: Assess site suitability
Action 3: Install bioreactor

Objective 2: Install 10 structures for water control and drainage water management practices to control phosphates.

Action 1: Contact eligible landowners
Action 2: Assess site suitability
Action 3: Install water control structures

Problem Statement 5: About 43 miles of stream has only fair levels of biological performance caused by about 20 ton of excess nutrient enrichment (nitrates) from cropland runoff and agricultural tile drainage systems.

Goal 1: Reduce nitrate loading from agricultural cropland runoff by 10 percent or about 1.76 pounds per acre per year for 4 consecutive years.

Objective: Treat 50 cropland fields per year (approximately 2,600 acres) with nitrate reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Design, print and distribute one fact sheet describing practices offered and economic and environmental benefits.
Action 2: Target outreach (specifically a fact sheet) and quality technical assistance to generate higher levels of nitrate reduction implementation.
Action 3: Train agriculture professionals (Certified Crop Advisors) in EQIP Management Systems approach, program availability and benefits
Action 4: Engage farmers to enroll fields
Action 5: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.
Action 6: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Goal 2: Reduce nitrate loading from agricultural cropland tile drainage systems by about 5 pounds per acre per year.

Objective 1: Install one (1) bioreactor to trap nitrates

Action 1: Contact eligible landowners
Action 2: Assess site suitability
Action 3: Install bioreactor

Objective 2: Install 10 structures for water control and drainage water management practices to control nitrates.

Action 1: Contact eligible landowners
Action 2: Assess site suitability
Action 3: Install water control structures

Goal 3: Improve nitrate use efficiency by 25-40 pounds per acre per year on average.

Objective 1: Engage 15 to 20 producers to implement adaptive management approach to nutrient management.

Action 1: Develop partnership with certified crop advisors
Action 2: Acquire new aerial imagery annually
Action 3: Annually collect and analyze key indicators of nutrient use efficiency using cornstalk nitrate testing and yield data.
Action 4: Compare relative efficiency and effectiveness of different management practices using replicated strip trials. Statistically analyze results from strip trials using Analysis of Variance (ANOVA) and PROC MIXED
Action 5: Document/quantify edge-of-field and downstream water quality benefits of practice implementation using the ARS CEAP infrastructure.
Action 6: Review analysis of data for publication as fact sheets, updates, and articles in scientific and farm publications
Action 7: Advance adaptive management approach to nutrient management and quantify benefits using via Ph.D. graduate thesis.
Action 8: Implement extensive communications and outreach strategy targeted to crop consultants, district staff, and additional federal and state agency experts to ensure technical experts have the information they need to understand the value of a networked, adaptive management approach and how it can be implemented at the local and regional watershed level.
Action 9: Target outreach and quality technical assistance to generate higher levels of nitrate efficiency implementation.
Action 10: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.
Action 11: Involve farmers in nutrient efficiency network to advance adaptive management approach to nitrate management and increase accountability and validation of impact.
Action 12: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Problem Statement 6: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 20 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 2: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Sample Hoover Reservoir at least twice a month, year round

Action 2: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 3: Report concerns to UBWC WQ Partnership

Goal 3: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average

Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Duncan Run Subwatershed

14 Digit HUC: 05060001130080
Location: Duncan Run and Tributaries RM 41.00
Drainage Area: 17.17 square miles, 10,990 acres
Miles of Stream: 24.6
Average Sinuosity: 1.20

Concerns from local communities:

- Increase in urban runoff and stormwater
- Atrazine pesticide levels
- Streambank erosion and accelerated down-cutting of the streambed
- Excessive lawn fertilizer washing into streams
- Phosphorus in streams increasing occurrence of algal blooms
- Some failing septic systems (aerators and leach fields)
- Degrading water quality

Subwatershed Description

Duncan Run is the fifth largest of the eight subwatersheds in the project area. The subwatershed is defined as the area of land draining into the Duncan Run watershed. This watershed drains mostly agricultural and forested land in southeastern Delaware County. Portions of this subwatershed lie within Delaware and Licking County and covers portions of Harlem and Genoa Townships in Delaware County and Jersey and Monroe Townships in Licking County (map 4-15). Center Village and Harlem are the two largest communities. The highest subwatershed elevation is 1,219.5 feet and the lowest elevation is 840.6 feet. Total relief is 378.9 feet.

Duncan Run begins in western Licking County where it flows northwest into Delaware County. Duncan Run flows for a total of 13.3 miles until it empties into Hoover Reservoir just north of Smothers Road. There are numerous unnamed tributaries that feed into Duncan Run and one that feeds directly into Hoover Reservoir. None of the small feeder streams are named on the USGS topographic maps but local names include: Spring Run, Suet Lick, Battee Ditch, and Gorsuch Joint County Ditch. According to Delaware SWCD data, this subwatershed has 8.5 miles of open drainage maintenance projects, 8 miles of open but unmaintained projects and .5 miles of maintained projects. The 100-year floodplain acres make up nearly 2.7 percent of the subwatershed or about 294 acres.

Land use in this subwatershed is similar to the other 14-digit HUC watersheds. Agricultural production dominates at about 70 percent land use, with about 69 percent in row crop production and nearly1 percent in pastureland (table 4-64 and map 4-16). Forest land use comprises 54 percent of the land cover within the 100-year floodplain followed by 32 percent open water, and 13 percent agriculture. When examining the 100’ buffers around all surface waters, row crop production dominates with 54 percent of the land use. Forested and wetland areas encompass 39 percent while residential areas cover about 5 percent of the land within the 100 foot stream buffers (table 4-65).

Table 4-64. Duncan Run Subwatershed Land Use

Description	Acres	Percent of watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	1,858	16.91
Pasture	87	0.79
Residential	1,357	12.35
Row Crops	7,587	69.03
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	101	0.92
Total	10,990	100.00

Table 4-65. Land Use Within 100' Stream Buffer for Duncan Run Subwatershed

Description	Acres	Percent of watershed
Commercial/Industrial/Transportation	0.00	0.00
Coniferous Forest	0.00	0.00
Deciduous Forest	210	38.95
Pasture	3	0.53
Residential	26	4.88
Row Crops	289	53.53
Urban/Recreational Grasses	0.00	0.00
Woody Wetlands	0.00	0.00
Water	11	2.11
Total	540	100.00

Table 4-66. Ohio Wetland Inventory Acres for Duncan Run Subwatershed

Farmed wetland	Shallow marsh	Shrub/ scrub wetland	Wet meadow	Wet woods
19.3	25.9	19.2	11.5	473.4

Table 4-67. Percent Land Use Type Within 100-foot Buffers of the Open Watercourses for Duncan Run Subwatershed, 1999-2003 OEPA-DSW Cover Map

Forest	Pasture	Urban	Row crops	Woody wetlands	Water
39.0	.53	4.9	53.5	0	2.1

Soils

The major soils are Bennington, Centerburg, and Pewamo on ground moraines and end moraines. Together these three soils comprise nearly 88 percent of the soils in the subwatershed. About 212 acres or nearly 2.0 percent of the subwatershed are Lobdell and Sloan soils which are classified as alluvial (floodplain) soils and are subject to occasional flooding. Over 3,700 acres or about 35 percent of the soils have slopes greater than 2 percent and are subject to erosion. About 2 percent of the soils are considered moderately eroded. Tables 4-68 thru 4-71 provide

acreages for hydrologic soil group classification, hydric soils, prime farmland, and drainage class. More detailed information about the soils is given in the soil surveys of Delaware and Licking counties.

Table 4-68. Hydrologic Soil Group Classification for Duncan Run Subwatershed (SSURGO)

Hydrologic group acres						
A/D	B	B/D	C	C/D	D	Not rated
	45.8	216.1	6,737.6	3,751.9	117.9	120.7

Table 4-69. Hydric Soil Rating (acres) for Duncan Run Subwatershed

All hydric	Not hydric	Partially hydric	Unknown
1,535	0	8,747	708

Table 4-70. Percentage of Soil Considered Prime Farmland if Drained and Not Flooded and Acres of Prime Farmland, Prime Farmland if Drained, Farmland of Local Importance, and Prime Farmland for Duncan Run Subwatershed

Prime farmland acres	Prime farmland acres if drained	Percent prime farmland if drained and not flooded	Farmland of local importance (acres)	Not prime farmland (acres)
1,246	9,310	85 percent	38	395

Drainage Class

Drainage class (natural) refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. The Duncan Run subwatershed has the highest percentage of somewhat poorly drained to very poorly drained land in the study area at 84 percent. Approximately 88 percent of the total cropland acres in the subwatershed relies on artificial drainage improvements (tile or tubing) in order to grow mesophytic crops without being restricted by wetness due to a seasonal high water table. Table 4-71 lists the acreage for each drainage class for Duncan Run subwatershed.

Table 4-71. Drainage Class Acreage for Duncan Run Subwatershed

Unknown	Moderately well drained	Poorly drained	Somewhat poorly drained	Very poorly drained	Well drained
121	1,363	17	5,293	4,000	196

Water Quality

According to the OEPA 2005 TMDL, Duncan Run was impacted by channelization and siltation, especially in the upper reach, along with elevated nutrients and high bacterial counts from agricultural activities and failing HSTS.

Biological

Duncan Run subwatershed has been given a WWH aquatic life use designation and a Primary Contact Recreation (PCR) designation. Failing home sewage treatment systems (HSTS) led to

Duncan Run periodically not attaining the PCR designation due to peak bacterial levels for one or both E. coli and fecal coliform bacteria. Duncan Run subwatershed has a total of 9.5 stream miles that are in non-attainment of the WWH use designation. Habitat alteration, siltation, pathogens, and nutrients were listed as the main causes of impairment . The main sources of impairment, as listed in the OEPA 2005 TMDL, are channelization, failing HSTS, loss of riparian corridor, agricultural practices, and range land management.
There was only one monitoring site (RM 9.0) on Duncan Run that reported an ICI score. The site received a Low Fair score which means there was a significant departure from the ecoregion biocriterion to give this reach a non-attainment status. This subwatershed needs further monitoring to assess the impacts land use practices are having on the biological community. Currently, the USDA, Agriculture Research Service is performing research in this area to ascertain the impacts agricultural conservation practices are having on the physical habitat, water chemistry, and biological communities. Their findings are not yet available for this report.

Physical
According to the OEPA 2005 TMDL, all segments of Duncan Run have physical impairments caused by habitat alteration and siltation. Sources of these impairments are channelization and removal of riparian vegetation.

The OEPA had one monitoring site located within the Duncan Run subwatershed near Robbins Road. This monitoring site is located within a stretch of open but unmaintained drainage ditch in eastern Delaware County. The QHEI score at this site was 57.5, which is just below the threshold for the WWH use designation (4 percent deviation from target). Fair or poor channel development and no fast current was listed as the influencing factors leading to the lower score. Again, this subwatershed has over 8 miles of open but unmaintained ditches and .5 miles of maintained ditches. Channelization has a direct correlation to instream and riparian habitat conditions and the observed QHEI scores reflect this. Although most of these ditches are no longer maintained, the impacts of past dredging practices have had a major impact on the quality and diversity of instream and riparian habitat. TMDL scores for sediment were 33.5 and the habitat score was 2. Target scores for these parameters were set at ≥33 and 3 respectively.

Chemical
The Big Walnut Creek TMDL did not model pollutant loading within this subwatershed. However, the TMDL does list elevated nutrients and high bacterial counts that were observed. The source of these impairments is listed as agricultural activities and failing HSTS.

As in other subwatersheds, pesticide runoff, primarily atrazine, continues to be a concern. Overland runoff or infiltration into subsurface drainage systems continues to be the main source for this nonpoint source pollution. Phosphorous and fecal coliform continue to be a concern in this subwatershed. Possible sources for these impairments are agricultural land use and failing home sewage treatment systems.

The Ohio EPA has authorized one NPDES Permit (4PT00125) to discharge from the Hylen Souders Elementary School wastewater treatment works located at 4121 Miller Paul Road, Galena, Ohio, Delaware County and discharging to an unnamed tributary to Duncan Run.

Additional information on this permit is available on the OEPA Division of Surface Water website.

Problem Statements

Problem Statement 1:
About 9.5 miles of stream has only fair levels of biological performance (ICI and QHEI scores not meeting WQS) caused by physical habitat degradation (channel modifications) from direct alteration of the stream channel and removal of riparian vegetation.

Goal 1: Improve in-stream physical habitat to about 9.5 miles of impaired stream channel to increase and maintain QHEI scores at 60 points or more.

- Objective 1: Inform, educate and encourage landowners to utilize professional and technical services, best management practices, and incentives to minimize the detrimental impacts to stream habitat resulting from the alteration of natural drainage.
  - Action 1: Develop contact list for landowners adjacent to impaired stream channel segments
  - Action 2: Make available to all owners of land adjacent to impaired stream segments copies of the Ohio Drainage Report, Ohio Drainage Law (summary), and Ohio Drainage Manual (Draft III)
  - Action 3: Provide landowner drainage management workshops upon request and as needed for new group projects.
  - Action 4: Develop list of strategies to encourage stream protection, establish priorities, and discourage non-recommended drainage actions.
- Objective 2: Establish procedure to assure that all channel management activities and practices under maintenance minimize negative QHEI score impacts.
  - Action 1: Score all new channel management projects prior to undertaking modifications or restorations.
  - Action 2: Establish review team to evaluate new project proposals and determine projected QHEI score.
- Objective 3: Apply current best management strategies and practices on all new stream channel modification and existing maintenance projects.
  - Action 1: Adhere to all NRCS drainage maintenance specifications in the FOTG
  - Action 2: Develop watershed drainage evaluation service to review areas to be considered for maintenance using table format inspection form proposed in the draft Ohio Drainage Manual.
  - Action 3: Seek additional incentives to encourage adoption of best management practices for channel maintenance activity by exploring market-based approaches, such as water quality credit trading, and utilizing special grants.
  - Action 4: Require all new drainage projects be placed on permanent county maintenance

Goal 2: Increase riparian vegetation along nearly 10 miles of impaired stream to help increase and maintain QHEI scores at 60 points or more.

Objective 1: Establish 2 acres of woody riparian buffers to improve riparian physical habitat.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs.

Action 2: Provide landowners with an opportunity to attend field tours that demonstrate the benefits of riparian buffers.

Objective 2: Establish 5 new acres of herbaceous riparian buffers (filter strips) per year for 3 years.

Action 1: Mail letters and buffer program brochures to all landowners eligible to participate in riparian programs

Action 2: Conduct annual riparian buffer field tour

Problem Statement 2: About 9.5 miles of stream has only fair levels of biological performance (ICI and QHEI) scores not meeting WQS) caused by 8,500 ton of excess sediment loading (embeddedness) from adjacent cropland. Although, the sum of the substrate, channel, and riparian categories from the QHEI assessment at RM 5.0 on Duncan Run is 0.5 points more than the TMDL sediment target score of ≥ 33 the substrate score of 12 is 2 points less than the substrate target score of ≥14.

Goal : Reduce soil erosion from unprotected cropland by about 1,700 tons per year (.23 ton per acre per year) for 5 consecutive years

Objective 1: Establish 325 new acres per year of cover crops to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of cover crop implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 2: Establish 325 new acres per year of reduced tillage/residue management to avoid sediment runoff.

Action 1: Target outreach and quality technical assistance to generate higher levels of no-till implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish 5 new acres of filter strips per year to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 4: Establish one (1) acre of grassed waterways to control sediment runoff.

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Action 3: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 5: Establish 2 acres of critical area plantings to trap sediments before entering the stream.

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Problem Statement 3: Nearly 9.5 miles of stream have only fair levels of biological performance (ICI and QHEI scores not meeting WQS) caused by about 12,000 pounds per year of excess nutrient enrichment (phosphorus) from agricultural runoff and agricultural tile drainage systems.

Goal 1: Reduce phosphate loading from agricultural cropland runoff by 2,400 pounds per year for 5 consecutive years.

Objective 1: Treat 3,200 acres of cropland runoff per year with phosphorus reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Target outreach and quality technical assistance to generate higher levels of phosphorus reduction implementation.

Action 2: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 3: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Objective 2: Establish 5 new acres of filter strips per year to trap or control phosphates

Action 1: Update UBWC CREP brochure to reflect program changes

Action 2: Design, print and distribute one fact sheet describing practices offered and their economic and environmental benefits.

Action 3: Train agriculture professionals (Certified Crop Advisors) in CREP program availability, and benefits.

Action 4: Recruit farmers through continued and increased collaboration with the Delaware and Licking SWCDs, NRCS, FSA, farmer organizations, and agricultural consultants.

Action 5: Target outreach and quality technical assistance to generate higher levels of filter strip implementation.

Action 6: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Objective 3: Establish one (1) acre of grassed waterways to control runoff

Action 1: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. grassed waterway and filter strip.

Action 2: Target outreach and quality technical assistance to generate higher levels of grassed waterway implementation.

Objective 4: Establish 2 acres of critical area plantings areas to control runoff

Action 1: Target outreach and quality technical assistance to generate higher levels of critical area planting implementation.

Action 2: Evaluate areas of concentrated flow to determine need for combining additional best management practices, e.g. critical area planting and filter strip.

Goal 2: Reduce dissolved reactive phosphate loading from agricultural cropland tile drainage systems by 1,000 pounds per year.

Objective 1: Install one (1) bioreactor to trap phosphates

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control phosphates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Problem Statement 4: Nearly 9.5 miles of stream have only fair levels of biological performance (ICI and QHEI scores not meeting WQS) caused by about 25 ton of excess nutrient enrichment (nitrates) from cropland runoff and agricultural tile drainage systems.

Goal 1: Reduce nitrate loading from agricultural cropland runoff by 10 percent or about 1.76 pounds per acre per year for 5 consecutive years.

Objective: Treat approximately 2,800 cropland acres per year with nitrate reduction management planning (cover crops and reduced tillage/residue management).

Action 1: Design, print and distribute one fact sheet describing practices offered and economic and environmental benefits.

Action 2: Target outreach (specifically a fact sheet) and quality technical assistance to generate higher levels of nitrate reduction implementation.

Action 3: Train agriculture professionals (Certified Crop Advisors) in EQIP Management Systems approach, program availability and benefits

Action 4: Engage farmers to enroll fields

Action 5: Conduct personal interviews with farmers, survey questionnaire mailings, form farmer focus groups and conduct local informational meetings.

Action 6: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Goal 2: Reduce nitrate loading from agricultural cropland tile drainage systems by about 5 pounds per acre per year.

Objective 1: Install one (1) bioreactor to trap nitrates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Objective 2: Install one (1) structure for water control and drainage water management practices to control nitrates.

Action 1: Assess the subwatershed to determine areas of highest priority.

Action 2: Contact landowners in high priority areas to determine willingness to install practice.

Action 3: Host field day with partners to discuss practices offered

Goal 3: Improve nitrate use efficiency by 25-40 pounds per acre per year on average.

Objective 1: Engage producers to implement adaptive management approach to nutrient management.

Action 1: Involve farmers in nutrient efficiency network to advance adaptive management approach to nitrate management and increase accountability and validation of impact.

Action 2: Leverage existing planning and studies to increase engagement with landowners/producers and target implementation based on data.

Problem Statement 5: Streams in this watershed periodically exceed the maximum contaminant level of atrazine allowable in finished drinking water caused by pesticide runoff or leaching into subsurface drainage systems from adjacent cropland used for corn production. On average, this subwatershed delivers approximately 84 pounds of atrazine pesticide per year to the mainstem of Big Walnut Creek which ultimately reaches Hoover Reservoir, City of Columbus drinking water supply.

Goal 1: Reduce atrazine loading from cropland to surface water to concentrations no greater than 2.5 parts per billion (ppb) running annual average.

Objective 1: Utilize voluntary program to reduce movement of atrazine from site of application to surface waters.

Action 1: Provide atrazine users with access to information on best management practices

Action 2: Inform producers when atrazine levels consistently exceed maximum contaminant levels.

Action 3: Seek access to funding, if necessary, to reduce surface water concentrations.

Goal 2: Maintain a sampling and monitoring program to evaluate and track trends in atrazine loading to surface waters.

Objective 1: Gather data relevant to the decision making process to protect surface water and drinking water quality.

Action 1: Conduct stream monitoring on weekly schedule, year round as funding permits

Action 2: Report concerns to UBWC WQ Partnership

Goal 3: Maintain herbicide task force as part of the UBWC WQ Partnership to act as the primary forum for providing watershed education, implementing local voluntary actions, and communicating local issues and concerns to the appropriate state agencies.

Objective 1: Provide for a local community action group to protect and preserve water quality.

Action 1: Seek professional and technical advice from university and other research agencies, industry, and the regulatory community if atrazine concentrations consistently exceed 3.0 ppb running annual average

Action 2: Utilize farmer-led task force to represent the agricultural community issues, concerns and solutions.

Problem Statement 6: About 9.5 miles of stream are periodically not attaining the primary contact recreational use designation at peak bacteria levels caused by the presence of pathogens (fecal coliform and *E. coli*) from failing home sewage treatment systems (HSTS).

Goal : Reduce pathogenic bacteria from failing HSTS discharge to restore the primary contact recreational use designation.

Objective 1: Utilize TMDL to prioritize watershed inspections.

Action1: Conduct annual inspections on 10 percent of off-lot discharging systems that directly outlet to a tributary.

Action 2: Utilize private sector service industry permit inspection program to help assure proper operation and maintenance of discharging systems and/or soil-based treatment and disposal systems.

Action 3: Document failed systems

Objective 2: Develop comprehensive HSTS database as inspections are completed.

Action: Gather and enter data on type of system, geo-coded location, year of installation, date of last inspection, date of last pumping, and sampling results.

Objective 3: Upgrade, repair or replace failing systems

Action 1: Implement repair or replacement procedures to bring systems into compliance.

Action 2: Introduce new, proven technology such as Wisconsin mounds, drip irrigation, and shallow trench or at-grade systems and integrate into current regulations.

Objective 4: Provide for education and outreach along with other informational programs and services to watershed residents on operation and maintenance of systems and assistance with corrective measures.

Action 1: Provide residents with opportunity to attend annual homeowner septic system operation and maintenance workshop.

Action 2: Assist qualified homeowners in identifying financial assistance for repairs or replacements or conversion to central sewer.

5.0 Listing of Acronyms

AFO: Animal Feeding Operation
ARS: Agricultural Research Service
AWARE: Agricultural Watershed Awareness Resource Evaluation
BOD_5: Biological Oxygen Demand – 5 Day
CAFO: Confined Animal Feeding Operation
CEAP: Conservation Effects Assessment Project
CREP: Conservation Reserve Enhancement Program
CRP: Conservation Reserve Program
EQIP: Environmental Quality Incentives Program
FOTG: Field Office Technical Guide
FSA: Farm Services Agency
GRP: Grassland Reserve Program
HSTS: Home Sewage Treatment System
IBI: Index of Biotic Integrity
ICI: Invertebrate Community Index
MCL: Maximum Contaminant Level
MRBI-CCPI: Mississippi River Basin Initiative-Cooperative Conservation Partnership Initiative
NHD: National Hydrology Data
NPDES: National Pollutant Discharge Elimination System
NPS: Nonpoint Source
NRCS: Natural Resources Conservation Service
OD: Oxygen Demand
ODA: Ohio Department of Agriculture
ODNR: Ohio Department of Natural Resources
OEPA: Ohio Environmental Protection Agency
OFBF: Ohio Farm Bureau Federation
QHEI: Qualitative Habitat Evaluation Index
RM: River Mile
SWCD: Soil and Water Conservation District
TSS: Total Suspended Solids
USDA: United States Department of Agriculture
USEPA: United States Environmental Protection Agency
USGS: United States Geological Survey
USRWP: Upper Big Walnut Creek Watershed Project
WAP: Watershed Action Plan
WHIP: Wildlife Habitat Incentives Program
WRP: Wetland Reserve Program
USGS: United States Geological Survey
USACE: United States Army Corps of Engineers
WWTP: Waste Water Treatment Plant
WWW: Warmwater Habitat

6.0 Bibliography

Baker, B.J., King, K.W., Fausey, N.R. 2005. Initial soil quality assessment within the Upper Big Walnut Creek watershed in Ohio [abstract]. ASAE Annual International Meeting. Paper No. 052048.

Barvenik, S., McGhee-Lenart, R., Tam, L., Engelberg, D. 2007. Total Maximum Daily Load Program Needs Better Data and Measures to Demonstrate Environmental Results. Evaluation Report No. 2007-P-00036, U.S. Environmental Protection Agency, Office of Inspector General.

Fausey, N.R., King, K.W., Dunn, R., Edwards, T., Ufferman, L. 2007. Conservation program (EQIP) reduces atrazine in Columbus, OH drinking water supply reservoir [abstract]. Soil and Water Conservation Society. p. 104.

IDEM (Indiana Department of Environmental Management). 2003. Indiana Watershed Planning Guide. Indian Department of Environmental Management. <www.in.gov/idem/catalog/documents/water/iwpg.pdf>. Accessed March 2005.

King, K.W., Smiley, P.C., Baker, B., Fausey, N.R. 2008. Validation of Paired Watersheds for Assessing Conservation Practices in Upper Big Walnut Creek Watershed, Ohio. Journal of Soil and Water Conservation. 63(6):380-395.

King, K.W., Smiley, P.C., Fausey, N.R., Baker, B.J. 2007. Validation of Paired Watersheds for Assessing Conservation Practices in Upper Big Walnut Creek Watershed, Ohio [abstract]. Soil and Water Conservation Society. p. 40

King, K.W., Fausey, N.R. 2006. Assessing Conservation Benefits and Costs. Ohio Country Journal. p. 47.

King, K.W., Smiley, P.C., Fischer, E.N., Fausey, N.R. 2006. Hydrology, water chemistry, and ecology of headwater streams in the Upper Big Walnut Creek Watershed, Ohio. ARS Conservation Effects Assessment Project-Watershed Assessment Studies Annual Meeting, Ames, Iowa, May 3-5, 2006. Abstract.

King, K.W., Smiley, P.C., Fausey, N.R. 2006. Hydrology and water chemistry responses to conservation practices and land use within the Upper Big Walnut Creek watershed. Meeting Abstract. Poster.

King, K.W., Smiley, P.C., Baker, B.J., Fausey, N.R. 2005. Assessing the impact of conservation management practices on water and soil quality in Upper Big Walnut Creek watershed [abstract]. ASAE Annual International Meeting. Paper No. 05-2128.

Liu, B.Y., M.A. Nearing, C. Baffault, and J.C. Ascough. 1997. The WEPP Watershed Model: Three Comparisons to Measured Data from Small Watersheds. Trans. ASAE 40:945-952.

Malcolm Pirnie, Inc., 1999. Upper Big Walnut Creek Watershed Water Quality Management Plan. Columbus, OH.

Napier, T.L., K. McCutcheon, and J. Fish. 2008. Factors affecting natural resource conservation investments of residents in the Lower Big Walnut Creek watershed, Ohio. Journal of Soil and Water Conservation 63(1):18-28.

NRCS (Natural Resources Conservation Service). 1997. National Handbook of Water Quality Monitoring. 450-vi-NHWQM. National Water and Climate Center, Portland, Oregon.

NRCS. 2005. National Conservation Practice Standards. www.nrcs.usda.gov/technical/Standards.

Ohio EPA. 1997. A Guide to Developing Local Watershed Action Plans in Ohio. www.epa.state.oh.us/dsw/nps/wsguide.pdf.

Ohio EPA, 2003. Biological and Water Quality Study of the Big Walnut Creek Basin 2000. Delaware, Fairfield, Franklin, Licking, Morrow, and Pickaway Counties, Ohio. EPA Technical Report DSW/EAS 2003-11-10. Ohio Environmental Protection Agency, Division of Surface Water, Columbus, OH.

Ohio EPA, 1989. The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application. Ohio, Environmental Protection Agency, Ecological Assessment Section, Division of Water Quality Planning and Assessment. Columbus, OH.

Ohio EPA, 2005. Total Maximum Daily Loads for the Big Walnut Creek Watershed. EPA Final Report August 2005. Ohio Environmental Protection Agency, Division of Surface Water, Columbus, OH.

Smiley Jr, P.C., et al., Influence of herbaceous riparian buffers on physical habitat, water chemistry, and stream communities within channelized agricultural headwater streams. Ecol. Eng. (2011), doi:10.1016/j.ecoleng.2011.03.020

Smiley, P.C., Gillespie, R.B., King, K.W., Huang, C. 2007. Fishes in drainage ditches: what does it mean for the management of agricultural watersheds?. Meeting Abstract. 2007 Ohio Stormwater Management and Drainage Conference, October 30-31, 2007. Columbus, Ohio. p. 3.

Smiley, P.C., King, K.W., Fausey, N.R. 2010. Public Health Perspectives of Channelized and Unchannelized Headwater Streams in Central Ohio: A Case Study. Journal of Water and Health. 8:577-592.

Smiley, P.C., King, K.W., Fausey, N.R. 2009. Influence of Herbaceous Riparian Buffers on Channelized Headwater Streams in Central Ohio. Meeting Abstract. Paper No. 92.

Smiley, P.C., King, K.W., Fausey, N.R. 2007. Developing restoration strategies for channelized headwater streams within a central Ohio watershed. Joint meeting of Ecological Society of America and Society for Ecological Restoration. COS 96-5.

Smiley, P.C., King, K.W., Fausey, N.R. 2006. An experimental approach to assess the influence of nutrient and pesticide practices on headwater agricultural watersheds in central Ohio. Meeting Abstract. p. 90.

Smiley, P.C., King, K.W. 2006. Fish-habitat relationships in drainage ditches within a predominantly agricultural watershed in central Ohio. Ecological Society of America Abstracts. p. 364.

Smiley, P.C., King, K.W. 2006. Ecological evaluation of the influence of herbaceous riparian buffers on headwater agricultural drainage ditches in the Upper Big Walnut Creek watershed. Meeting Abstract. p. 14.

Smiley, P.C., King, K.W., Baker, B.J., Fausey, N.R., Tennity, C., Sohngen, B. 2006. Evaluating conservation practices within the Upper Big Walnut Creek watershed: water quality, ecology, soil, and economic perspectives. Meeting Abstract. p. 15.

Smiley, P.C., King, K.W., Fausey, N.R. 2005. Evaluating habitat and fish community responses to conservation practices in headwater streams of Upper Big Walnut Creek. Meeting poster.

USDA (U.S. Department of Agriculture). 1996. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). Renard, K.G., G.R. Foster, G.A. Wessies, D.K. McCool, and D.C. Yoder, coordinators. U.S. Department of Agriculture, Agricultural Handbook No. 703. 404 pp.

USEPA. 2001b. Getting in Step: Engaging Stakeholders in Your Watershed. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2002a. 319 Success Stories, Volume III: The Successful Implementation of the Clean Water Act's Section 319 Nonpoint Source Pollution Program. EPA 841-S-01-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA. 2003c. Getting in Step: A Guide for Conducting Watershed Outreach Campaigns. EPA 841-B-03-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

7.0 Watershed Action Plan Evaluation

Introduction

The action plan evaluation process is integrated into the framework of the planning and implementation process. It is intended to assist in accomplishing the goals and objectives of the plan by continually focusing, adjusting and aligning project activities. The evaluation process is more formally referred to as the adaptive management approach and it serves to acknowledge the need to monitor water quality and land treatment and to measure progress toward meeting goals. The evaluation plan may also be considered an outcome study. It seeks to reveal how well the watershed community has come together to accomplish the purpose of the action plan. This chapter outlines how watershed action plan goals and objectives are being evaluated. The effectiveness and success of the plan as a whole is examined during the evaluation process. There will always be an ongoing need to evaluate the plan in order to respond to the dynamics of the watershed landscape and the specific challenges presented. In general, evaluation is accomplished using a set of criteria to determine if pollutant load reductions are being attained and to verify that progress is being made towards water quality improvement goals. If sufficient progress is not being made then the watershed action plan is revised accordingly.

The following section addresses some primary evaluation steps:

- Recognizing key stakeholder roles and responsibilities
- Making the plan easily accessible
- Communicating relevant plan information
- Recognizing Non Participatory Changes
- Tracking the progress of watershed action plan implementation
- Resources required to monitor the action plan

Recognizing Key Stakeholders

All stakeholders play some role and carry some degree of responsibility for the condition of our watershed resources. Identifying stakeholders that play key roles or have specific responsibilities above those of a general nature is imperative when evaluating the quality and effectiveness of the action plan. Typically, these key stakeholders come to the forefront during the planning process and many remain throughout the process. The implementation process retains many of those involved in planning but adds new stakeholders with different perspectives and areas of expertise. Collectively, this diverse group of individuals utilizes various methods to identify those within the group or outside the group with the capacity to critique, evaluate, and make continuous improvement suggestions. It is not uncommon, however, for an individual having only minor involvement with the project to identify key resource people as well.

It is important, and often falls on the coordinator to solicit a full vetting of any contentious or poorly understood issues within the group before making previously agreed to changes in the plan. Likewise, strong agendas from outside the key stakeholder group can test the fabric of the plan. Again, key stakeholders with extensive knowledge and experience provide the overall direction when it comes to evaluating the merits of the plan.

Plan Accessibility

Having the plan readily available and easily accessible provides the best opportunity for everyone to evaluate and provide comment. Access to watershed action plan, publicity and other plan-related information is discussed elsewhere in this publication. Access to watershed planning guides, technical references and related literature are easily available as well for more in-depth analysis and evaluation. There are no stipulations on how, when, or in what format evaluation comments are accepted. In general, simply making concerns known to the Delaware Soil and Water Conservation District or directly to the watershed coordinator is sufficient.

Communicating Information

A variety of forms of communication are employed in association with the evaluation process. Time constraints, degree of interest in specific plan components, and numerous other factors often determine how much attention is given to communicating the measurements of success and making formal adjustments to the plan. For the most part, the project coordinator plays a primary role in communicating relevant information to the appropriate individuals and groups. There are many approaches to effectively communicate progress and success in achieving watershed goals and objectives. By far, written communications through email, is the most frequently employed tool in communicating. Generally, this approach is effective in resolving most issues with the plan. Face to face meetings are employed when in-depth dialog becomes necessary. Occasionally, formal presentations of a technical or academic nature are used to assist in evaluating specific aspects of the plan. Coordinating large group meeting for the specific purpose of evaluating plan effectiveness is usually not necessary since most communication and needed adjustments take place on a daily or weekly basis.

Non Participatory Changes

The group participatory decision-making process is discussed in Chapter 2, Watershed Action Plan Development. However, reaching consensus on priorities and changes to the plan involves a more complex and complicated consulting process that commonly goes on in different circles of influence at different times before a particular issue comes to the attention of the project where it can be addressed in a more formalized setting. These “outside influences” may well be among the most influential part of the project evaluation process since they often initiate further examination and discussion of issues in a manner similar to paradigm shifts. By the time a specific shortcoming in the plan is ultimately identified by the primary decision-making group it may well have been debated and agreed upon by individuals far removed from the project. For example, high level regulatory and policy decisions are often poorly communicated into local watershed projects until long after decisions have been made. However, final outcomes of state and national decisions may call for plan changes at the local level in a “top down” fashion with little opportunity to use the participatory decision-making approach except for agreement about when and how to make revisions. Other unforeseen issues that expose shortcoming in the plan may come about through any number of dynamics ranging from evolving social and cultural issues to environmental changes. For example, fairly recent reports regarding pharmaceuticals in drinking water sources and the even more recent concerns over toxic algal blooms both exposed deficiencies in the plan that necessitated additional discussion and planning.

Tracking Progress

The primary focus is to determine how effective watershed action plan items are in improving water resources in the UBWC project area. The Upper Big Walnut Creek Watershed

Coordinator is responsible for tracking action plan progress. The coordinator will continue to use the advisory committee as a tool to incorporate group decision making during the tracking process. The advisory committee will receive updates on implementation projects throughout the year and will meet once a year to discuss whether sufficient progress has been made to improve water quality goals.

A detailed inventory of the watershed serves as the foundation upon which water quality impairments have been identified and goals have been established to reach water quality attainment status.

A flexible water quality sampling and monitoring component is being developed within the watershed in order to extend into areas not currently under observation. This will be done in concert with the research and monitoring activities being executed by the Agricultural Research Service and the City of Columbus. Sampling locations will be identified using a set of criteria that will insure monitoring sites are appropriately placed throughout the study area. This plan will assist the watershed coordinator, advisory committee, and watershed partners in assuring that water quality goals are being met through the implementation of Best Management Practices.

Resource Requirements

Generally, resource requirements necessary to develop, implement, and continually manage the watershed plan and watershed program are of two basic types. Direct financial resources primarily support staffing needs, i.e. compensation, equipment, materials & supplies, and personnel services. Guidance and technical resource documents and readily available assessment tools comprise the other important source of resources. Guides, technical documents and tools, are available in great abundance and usually do not constitute a “roadblock” when it comes to planning and implementation. Direct financial needs continually challenge administration of the watershed program and necessitate the application of teamwork, collaboration, networking, formal partnerships, leveraging, and other financially creative solutions.

Implementation of the Upper Big Walnut Creek Watershed Action plan currently relies on the availability of local (county & municipal), state, federal, and a minor amount of nongovernmental funding for program implementation and staffing. USDA Farm Bill related programs, various grants, state match and cost-share dollars are responsible for most of the direct implementation efforts. The project receives no voluntary donations or foundation grants. Specific resource needs for the implementation of water quality projects, programs, and activities are outlined in Chapter 4 of the watershed action plan.

8.0 GENERAL WATERSHED INFORMATION AND EDUCATION PROGRAM

This section describes the general information and education program component and includes a description of the specific efforts to explain the purpose and goals of the watershed partnership and watershed action plan to the general public.

What is the purpose of the watershed action plan?
The watershed action plan helps to accurately identify pollutants and pollution sources so that appropriate and effective solutions can be formulated. The quality of the water resource at any point in a stream is the product of all natural and human activities in the drainage area above that point. To positively affect water quality, all the sources of potential pollutants need to be identified and evaluated based on their relative pollution contribution.

What are the goals of the watershed action plan?
In general, the goals include itemizing the problems, priorities and activities the watershed group would like to address. The goals further serve as a guide for the watershed group to map a strategy for improving or protecting the watershed. Another goal is to foster a comprehensive understanding and appreciation of the watershed resources.

What is the purpose of the watershed partnership?
The Upper Big Walnut Creek watershed is unique and requires its own unique action plan. The watershed has specific characteristics and problems determined by such factors as population density, economics, geography and existing water quality. The watershed partnership is the best organization equipped to identify major issues of concern in the community and agree upon technical controls to improve water quality and watershed health. In addition, the partnership helps build local support for the watershed plan. The partnership involves stakeholders – individuals or groups that have an interest in the watershed – in the planning process from the beginning to prevent running into obstacles or opposition when the plan is implemented. Also, the partnership nurtures a sense of ownership by local citizens most affected by the plan and assists in incorporating local concerns and goals.

What are the goals of the watershed partnership?
Aside from the broad goals established in the organization's mission statement, the sponsor organization and partnership formulate goals for annual work plans. Annual project work plans are developed to cover all watershed initiatives, programs, activities, and specific site projects. Included within these plans is the Ohio Watershed Coordinator Grant Program, the USDA-Mississippi River Basin Initiative-Cooperative Conservation Partnership Initiative, the Conservation Partnership Local Work Group Plan for the Environmental Quality Incentives Program (including the special EQIP Program); urban storm water maintenance and project implementation plans (including education and outreach components), the USDA Agricultural Research Service Conservation Effects Assessment Program (including watershed-related components of the agencies' 5-year plan), and watershed components of the Delaware Soil and Water Conservation District's Annual Work Planning process. Each of these plans and associated goals are a matter of public record and become internalized in the watershed plan.

Specific Efforts to Inform and Educate the General Public

Specific efforts to explain the purpose and goals of the watershed partnership and watershed action plan to the general public are accomplished using a multiple-communication approach. Publicizing these efforts is typically initiated either through the proactive project work planning process or by unforeseen opportunities that present themselves in the way of individual or group requests. Providing information and education may come about by engaging the general public through direct personal contacts, participation at public events, workshops, and public speaking arrangements. Non-personal or indirect opportunities are often addressed through the use of mailings, distributing literature at sites frequented by the public, websites, and press articles.

Township newsletters
SWCD Newsletters
Sunbury News
Columbus Dispatch
City of Columbus Watersheds
Watershed project website and links to closely-related websites
Public events
Tours
Big Walnut High School
Sunbury Library
Workshops
CDs
Rural and suburban contacts

9.0 Watershed Plan Updating and Revision

Update Elements

The watershed project coordinator assumes the responsibility for watershed plan updating and revision. This process will be accomplished by completing the following tasks.

1. Providing user friendly access to watershed action plan.
2. Creating an effective and efficient revision process.
3. Updating watershed action plan annually to reflect changes within watershed.
4. Publicizing watershed action plan and implementation activities.

Several forms of delivery will be utilized to disseminate the watershed action plan to project partners and the general public. The Delaware SWCD web page is currently used to provide a direct link to the UBWC Watershed project page. A complete version of the WAP will be made available, via PDF download, on the watershed project page. There will be a limited number of bound copies available for dissemination and to be used as reference guides in the Delaware SWCD office. Fifty CDs will be made available to disseminate at partnership meetings and workshops.

The project Advisory Committee, Area Assistance Team, watershed coordinator, and other interested partners will begin the review process following the second year of the implementation phase and continue every two years. The watershed coordinator will continually update a working copy of the WAP as action items are implemented or additional issues arise. These changes will be reviewed by the aforementioned review team.

The watershed coordinator will assume the primary responsibility for publicizing the watershed action plan and providing interpretative assistance to users. Advisory Committee members and stakeholders are responsible for using and promoting the use of the watershed action plan as a means to improve and maintain the water quality resource in the project area.

Distribution List

City of Columbus, Division of Power and Water
Ohio Department of Natural Resources
    Division of Soil and Water Resources
    Division of Water
    Division of Wildlife
Ohio Environmental Protection Agency
    Division of Surface Water, Central District Office
    Division of Surface Water, Northwest District Office
Ohio Department of Agriculture
The Ohio State University Extension
Ohio Department of Transportation
Ohio Department of Economic Development
Ohio Department of Health
Delaware General Health District
Delaware County Soil and Water Conservation District

Franklin County Soil and Water Conservation District
Knox County Soil and Water Conservation District
Licking County Soil and Water Conservation District
Morrow County Soil and Water Conservation District
Delaware County Commissioners
Franklin County Commissioners
Knox County Commissioners
Licking County Commissioners
Morrow County Commissioners
Upper Big Walnut Creek Watershed Project Advisory Committee
U.S. Fish and Wildlife Service
U.S. Department of Agriculture
    Agriculture Research Service, Soil Drainage Research Unit, Columbus, Ohio
    Farm Service Agency
    Natural Resources Conservation Service

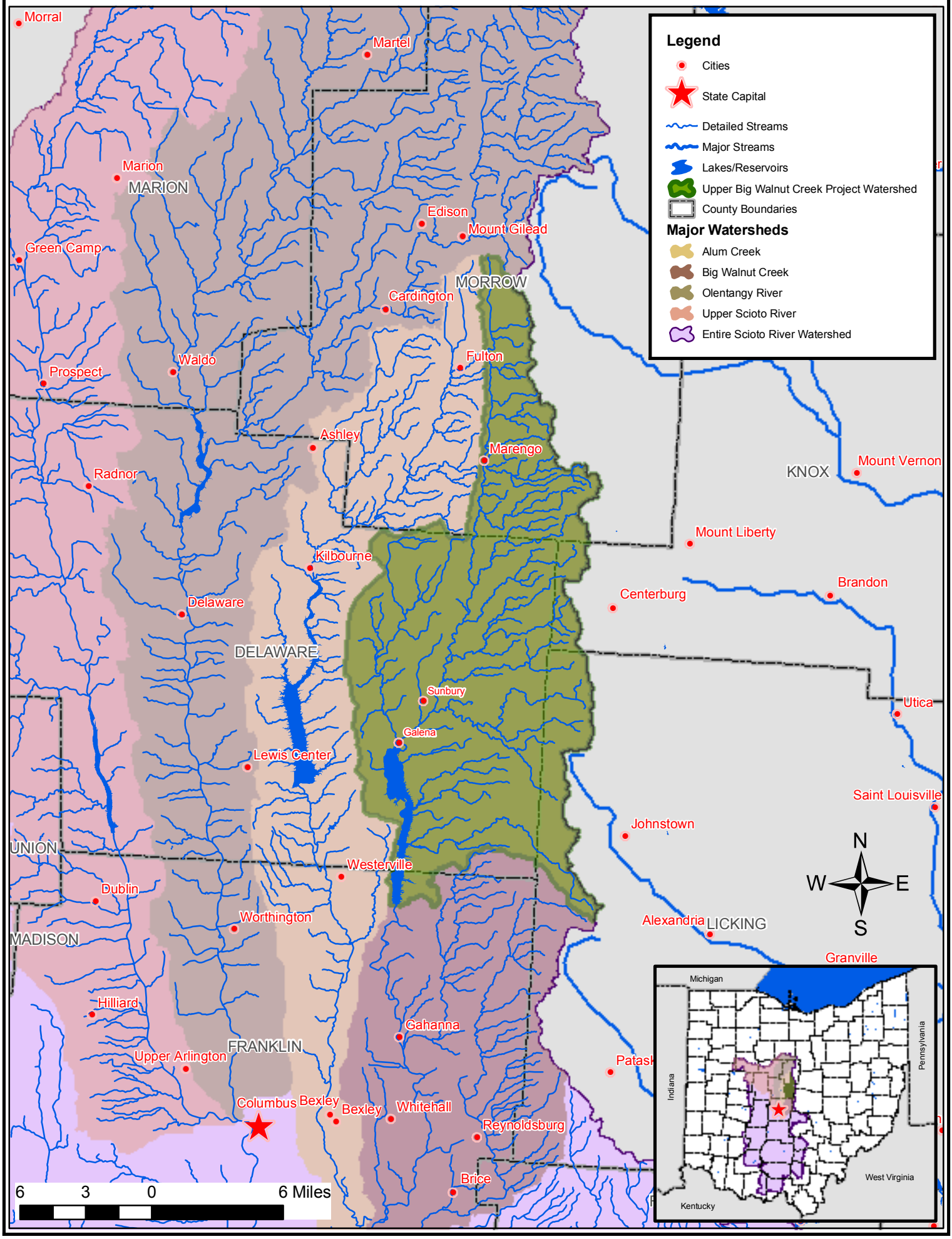
Contact Person

Ed Miller, UBWC Watershed Coordinator
Delaware Soil and Water Conservation District
557 Sunbury Road, Suite A
Delaware, Ohio 43015.
(740) 368-1921
Fax: (740)369-8321
www.delawareswcd.org

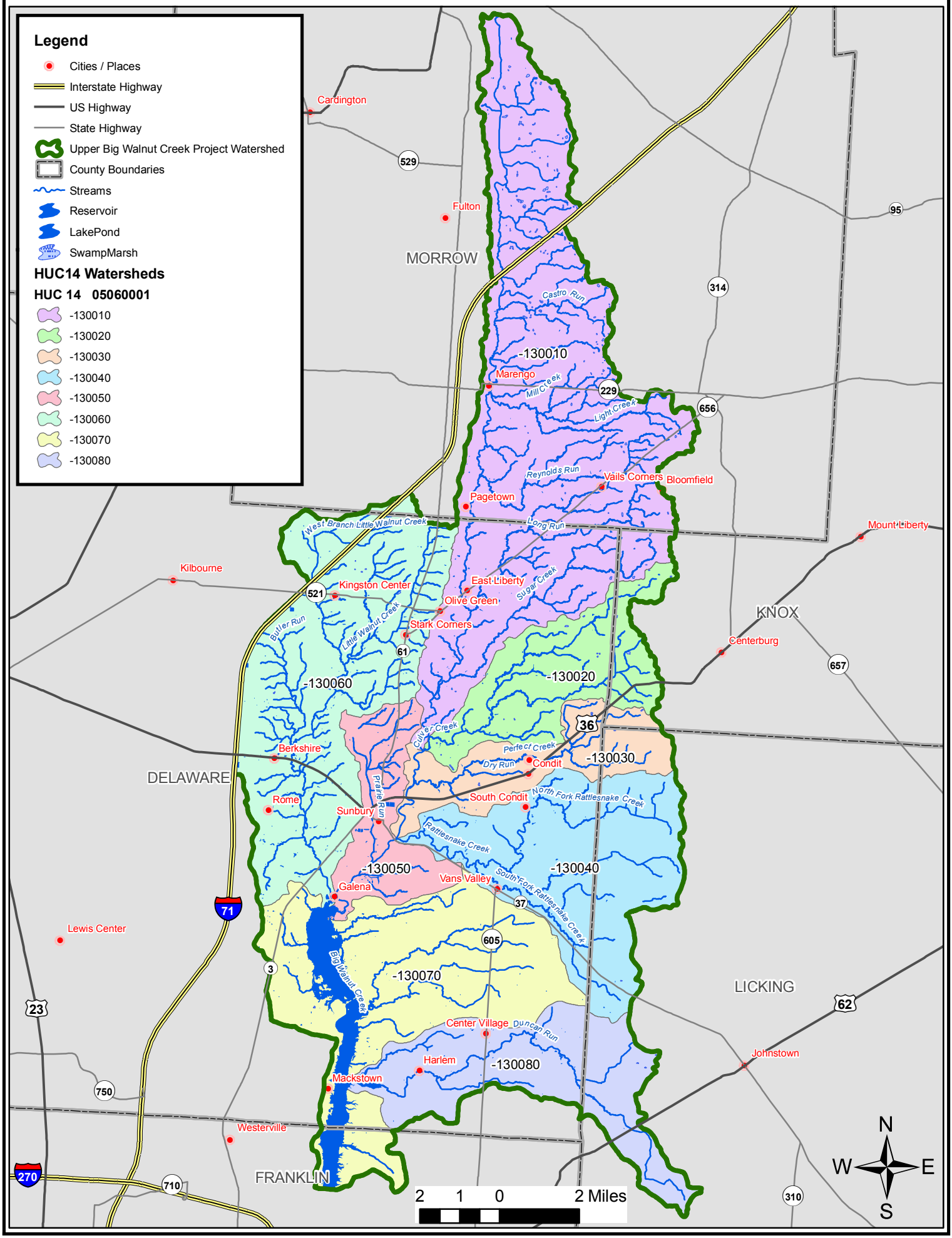
Record Keeping Organization

The Delaware Soil and Water Conservation District, 557 Sunbury Road, Suite A, Delaware, Ohio 43015

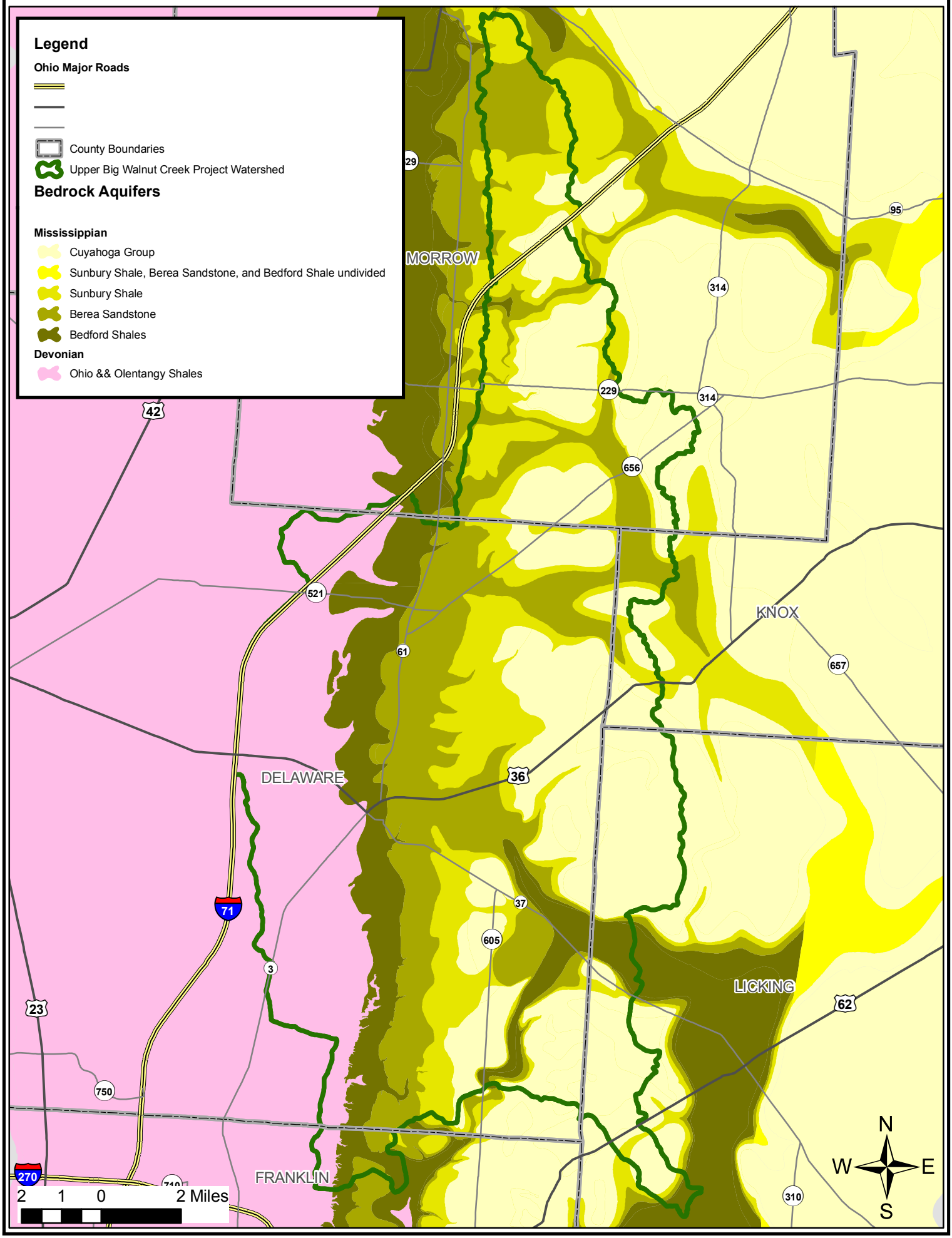
Map 1-1. Upper Big Walnut Creek Watershed Study Area



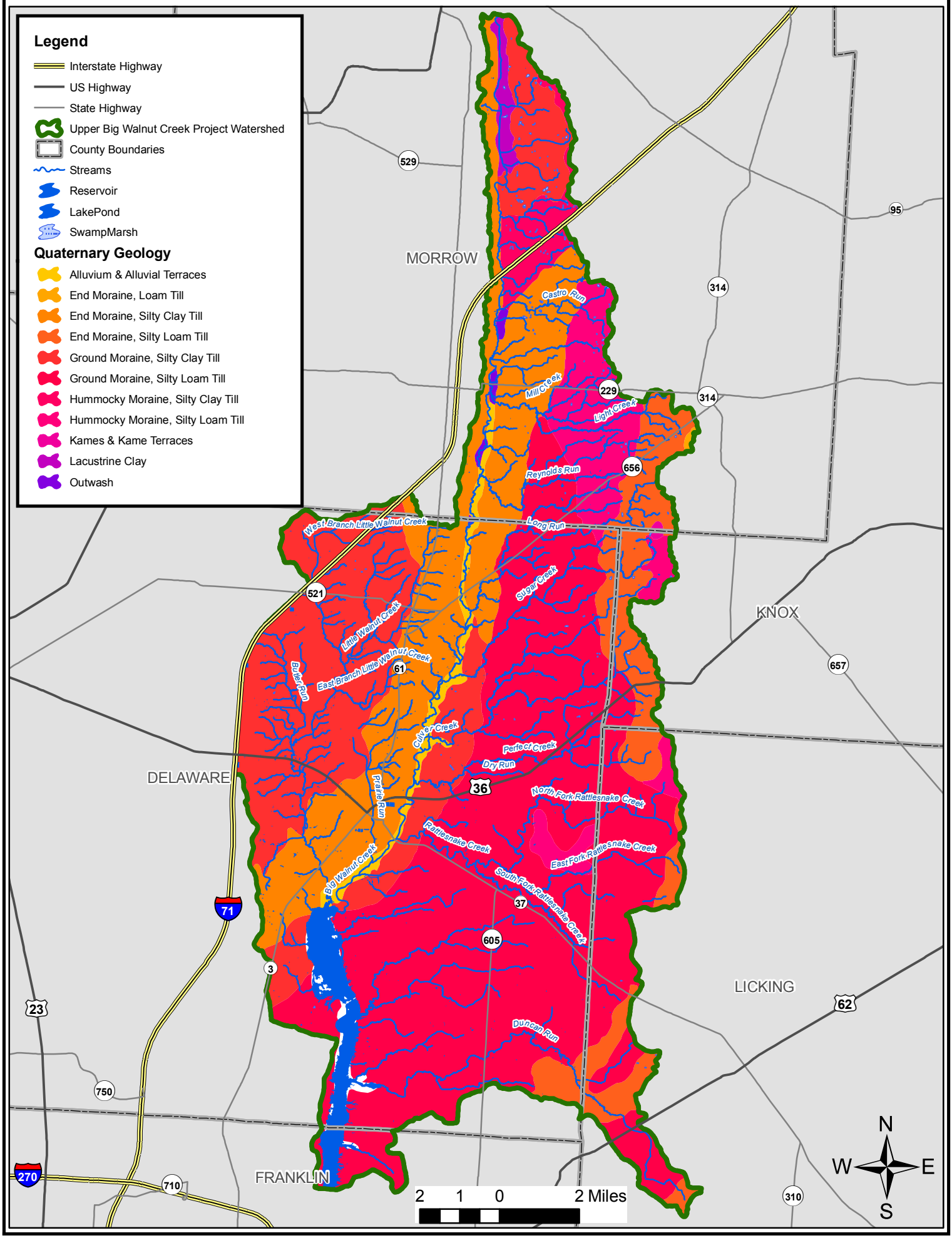
Map 1-2. Upper Big Walnut Creek 14-digit HUC Subwatersheds



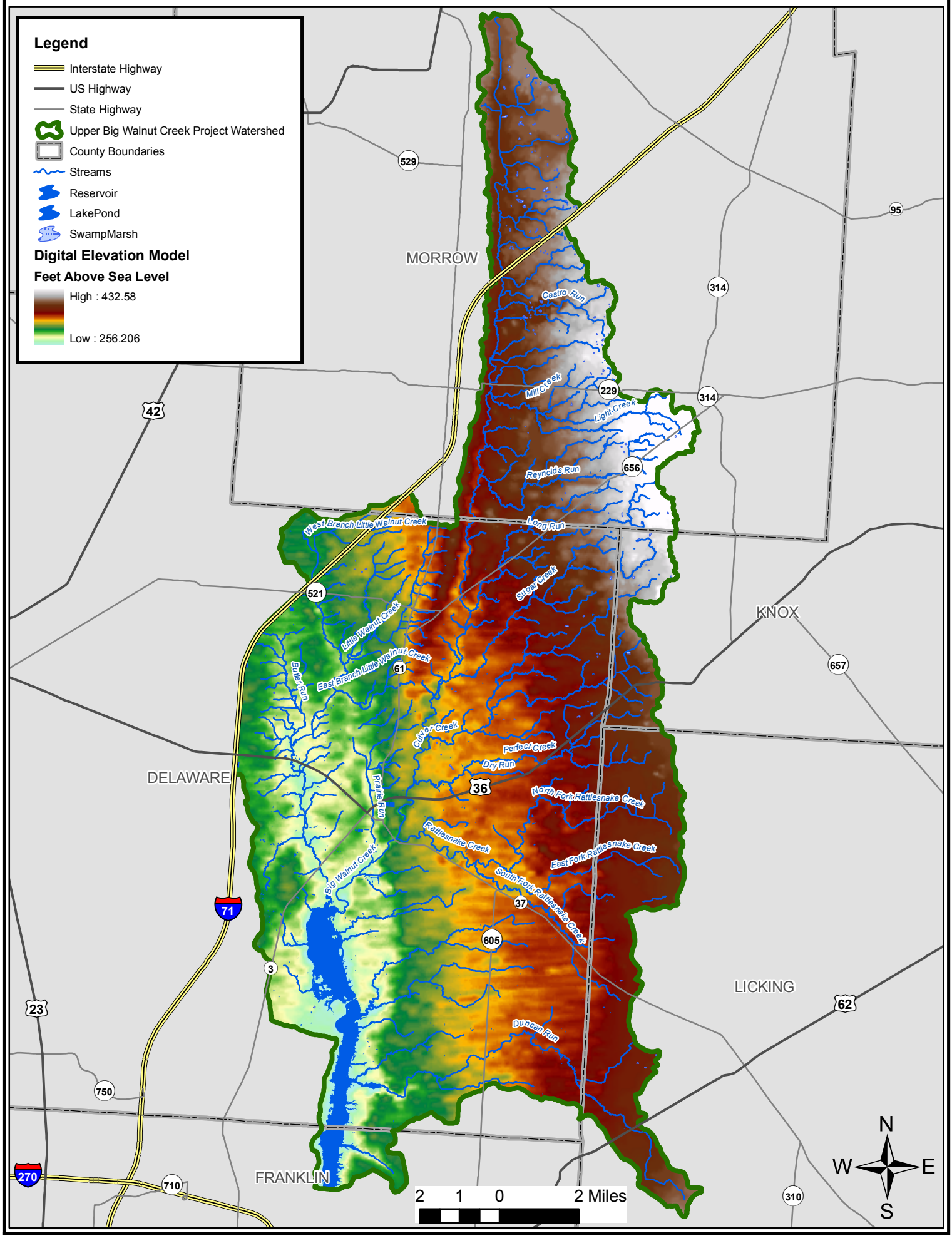
Map 3-1. Geologic Map of Upper Big Walnut Creek Watershed



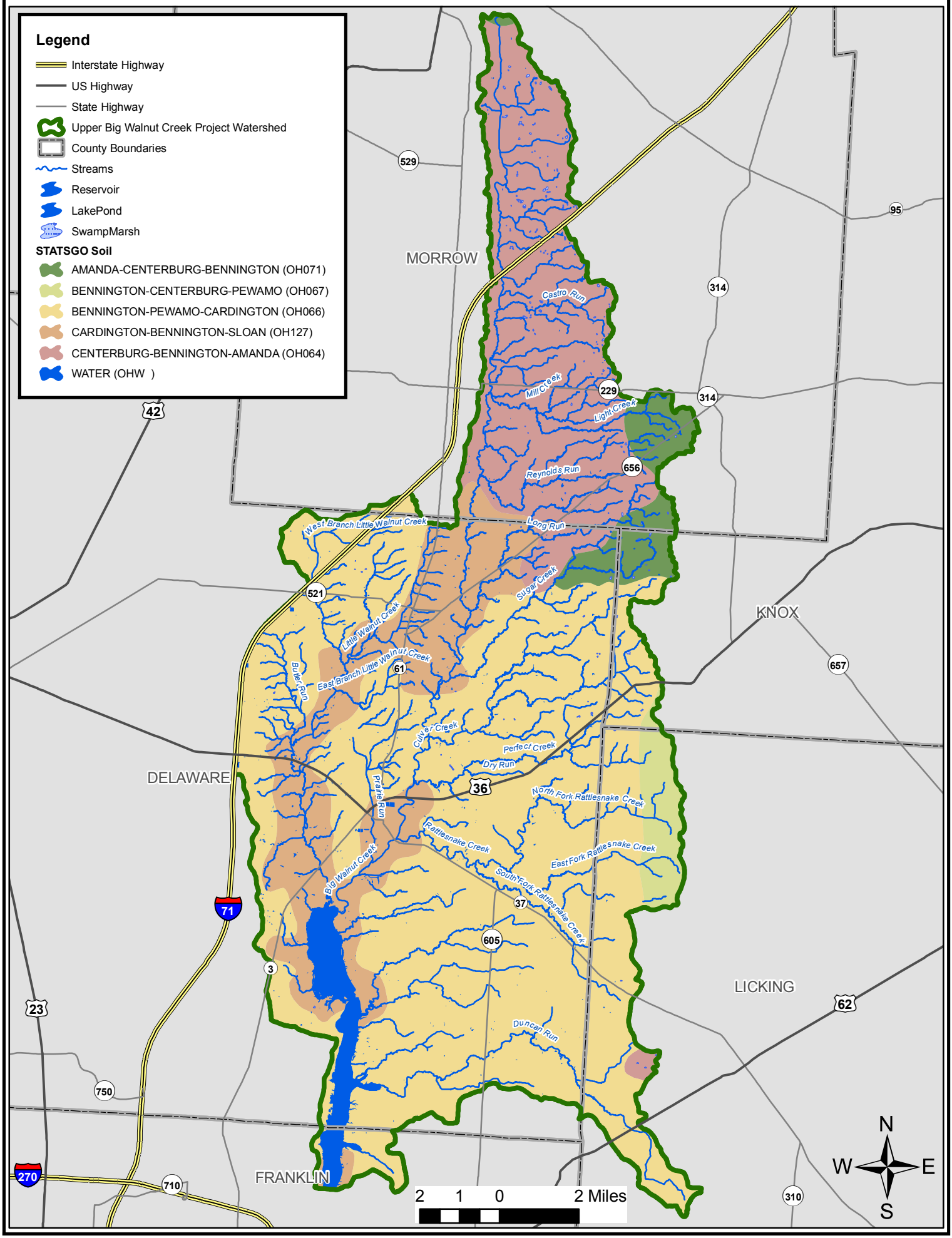
Map 3-2. Glacial Feature/Quaternary Geology of Upper Big Walnut Creek Watershed



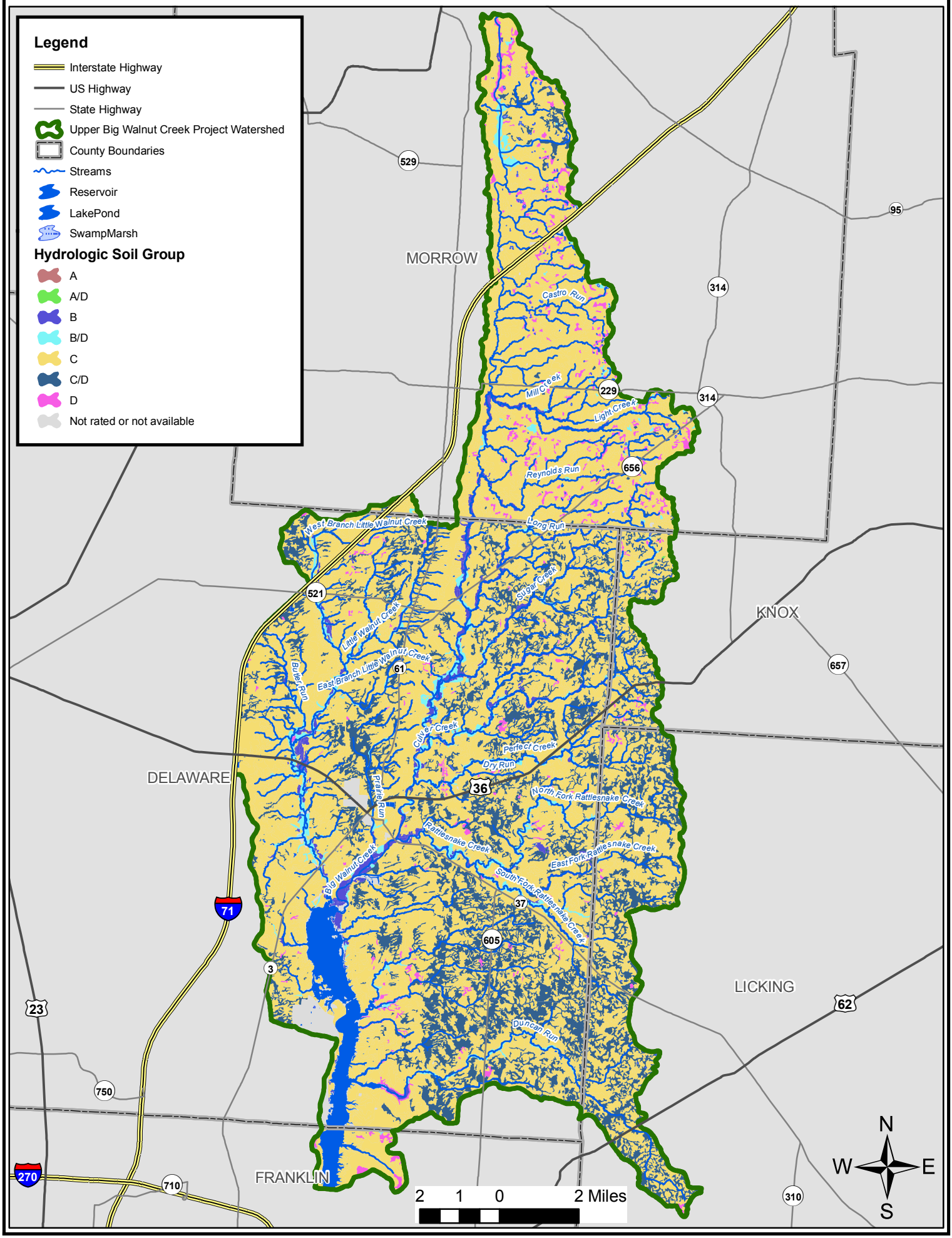
Map 3-3. Digital Elevation Map for Upper Big Walnut Creek Watershed



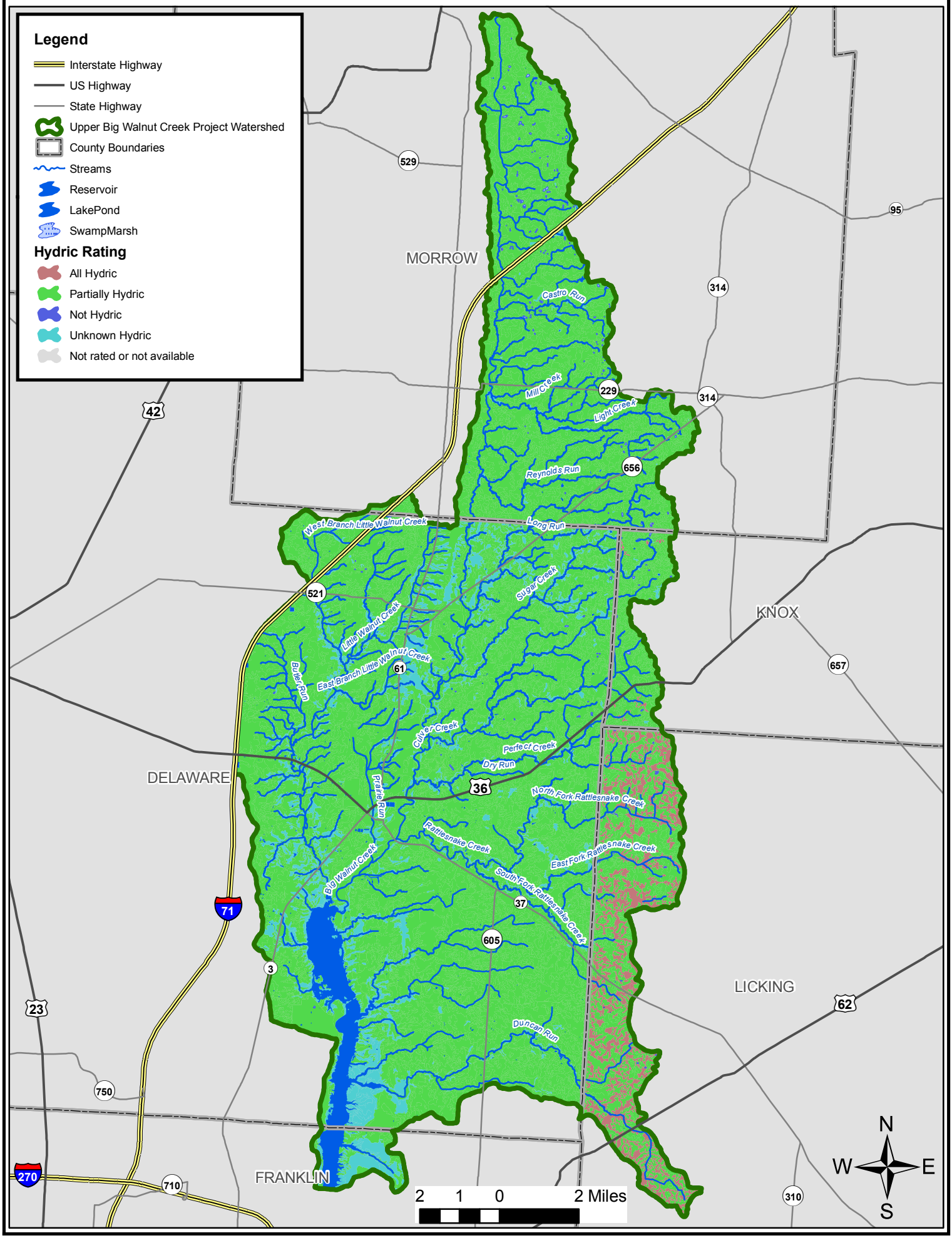
Map 3-4. Soil Group Associations Found in Upper Big Walnut Creek Watershed



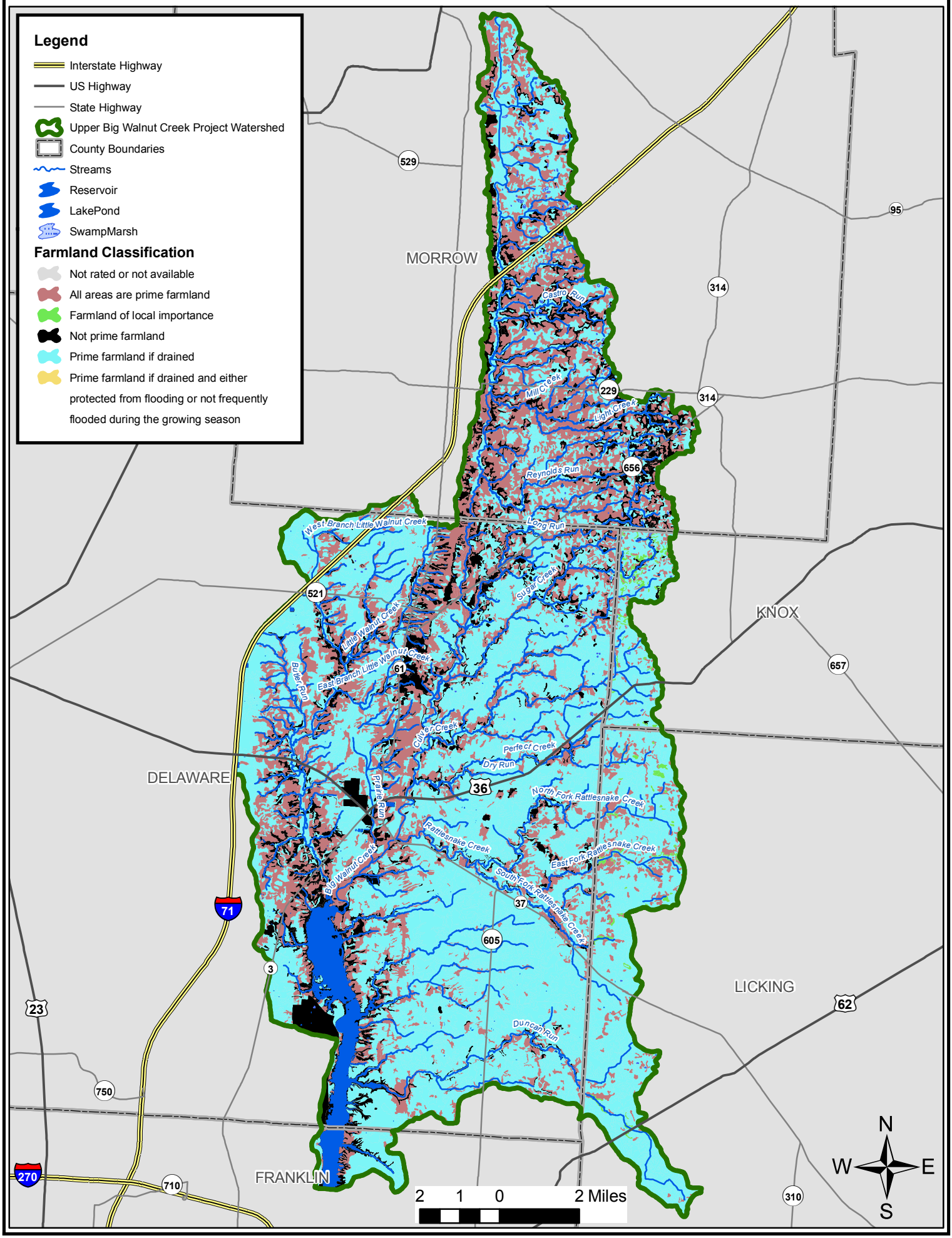
Map 3-5. Hydrologic Soil Groups in Upper Big Walnut Creek Watershed (SSURGO)



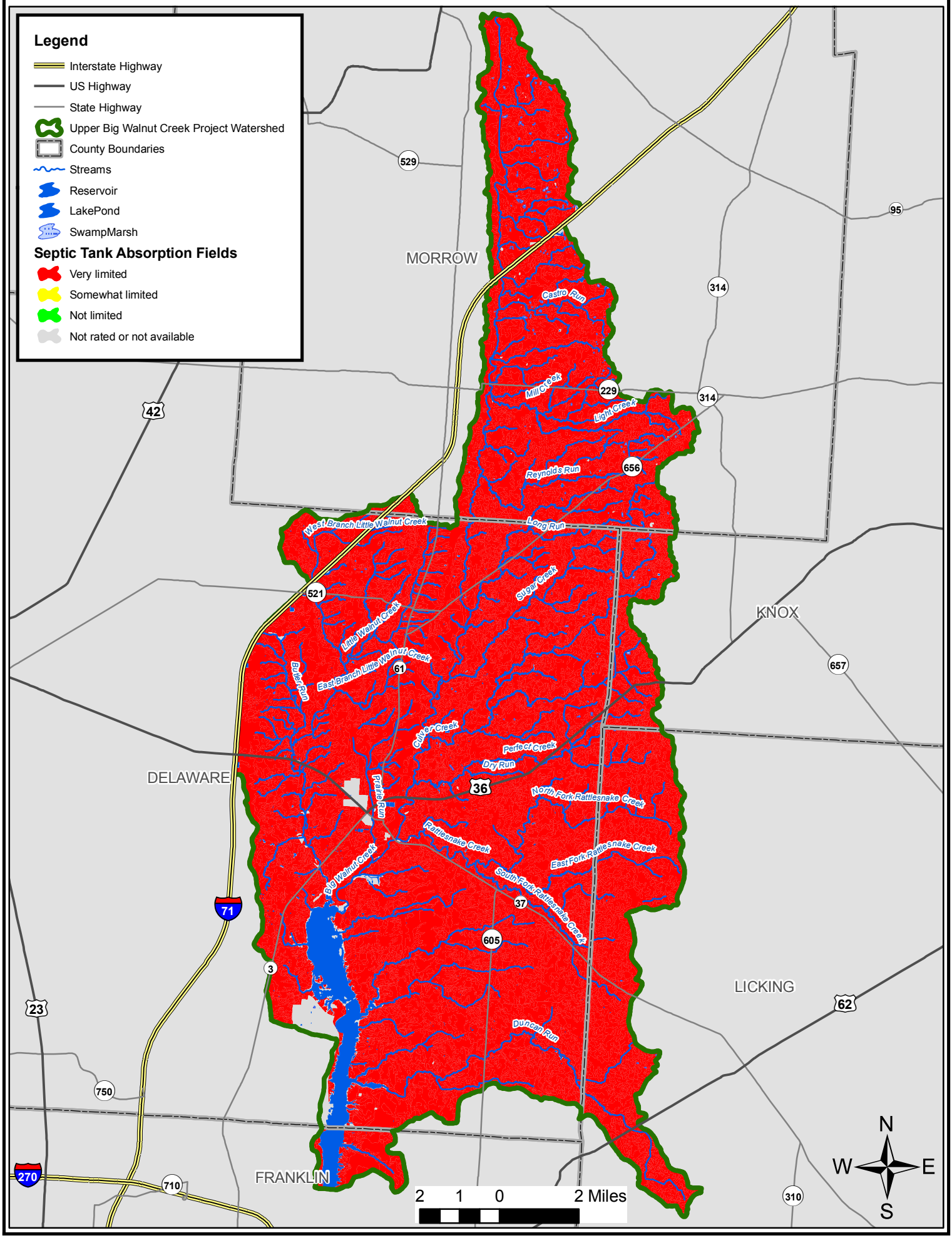
Map 3-6. Hydric Soil Rating in the Upper Big Walnut Creek Watershed (SSURGO)



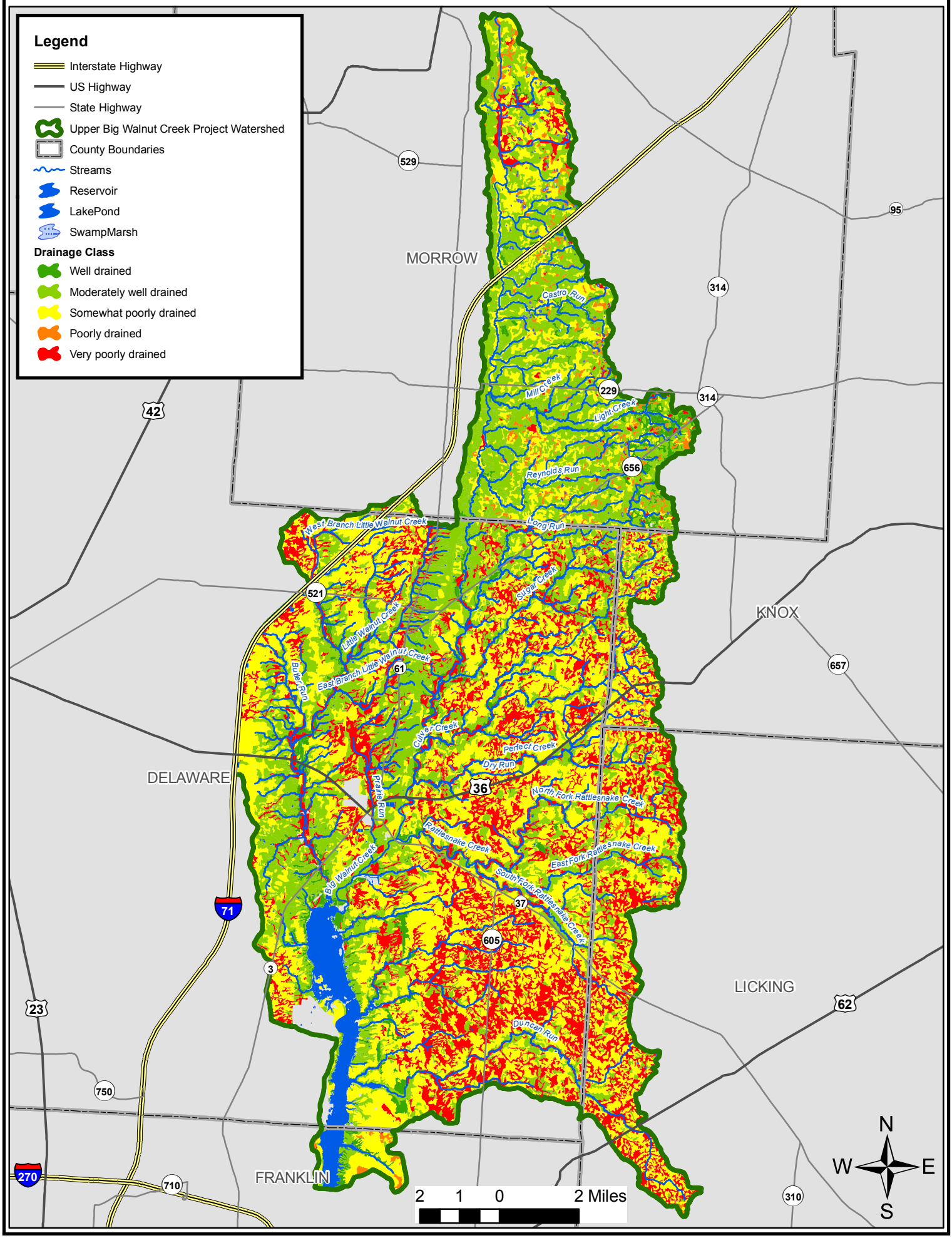
Map 3-7. Farmland Classification in the Upper Big Walnut Creek Watershed (SSURGO)



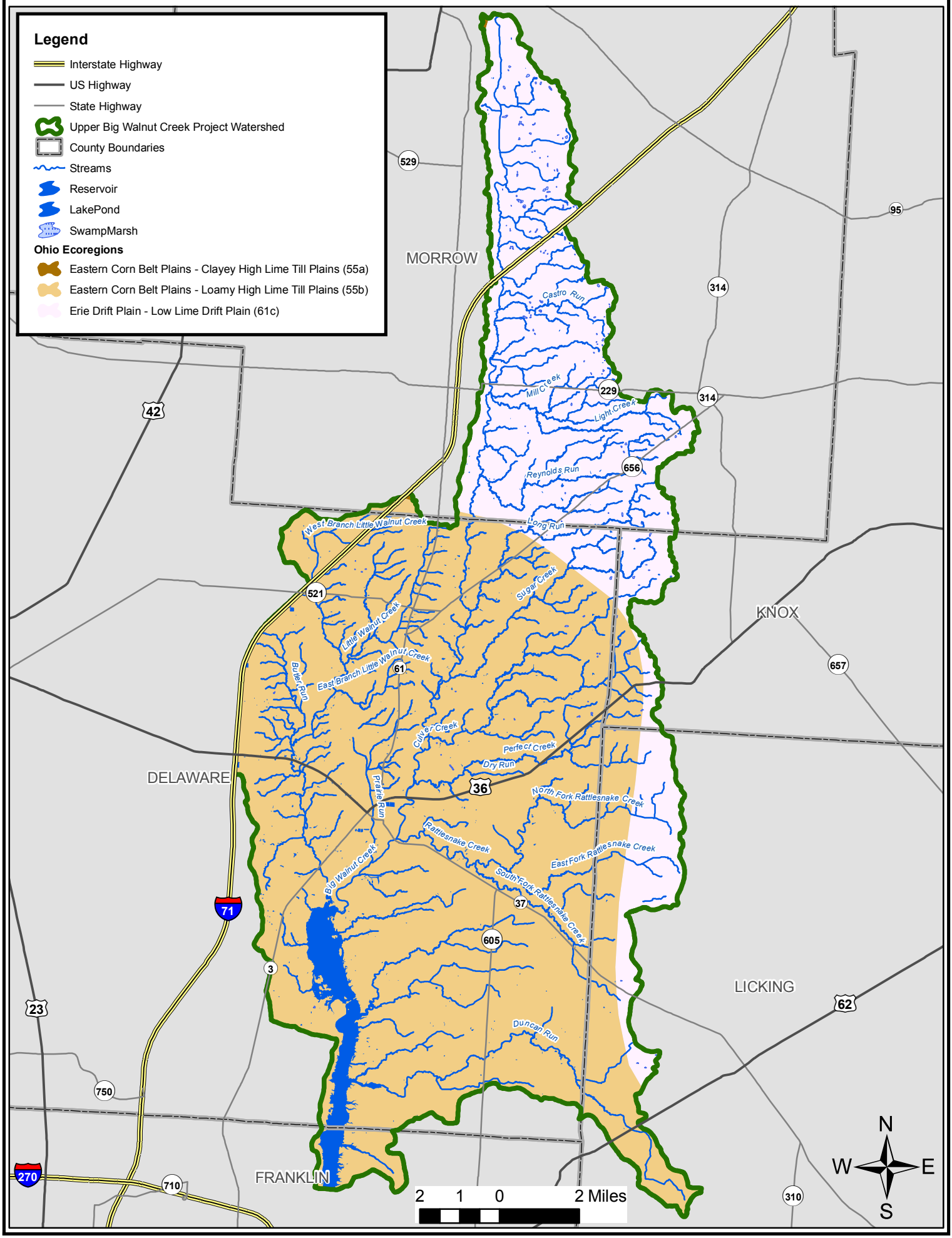
Map 3-8. Septic Tank Absorption Fields for Upper Big Walnut Creek Watershed (SSURGO)



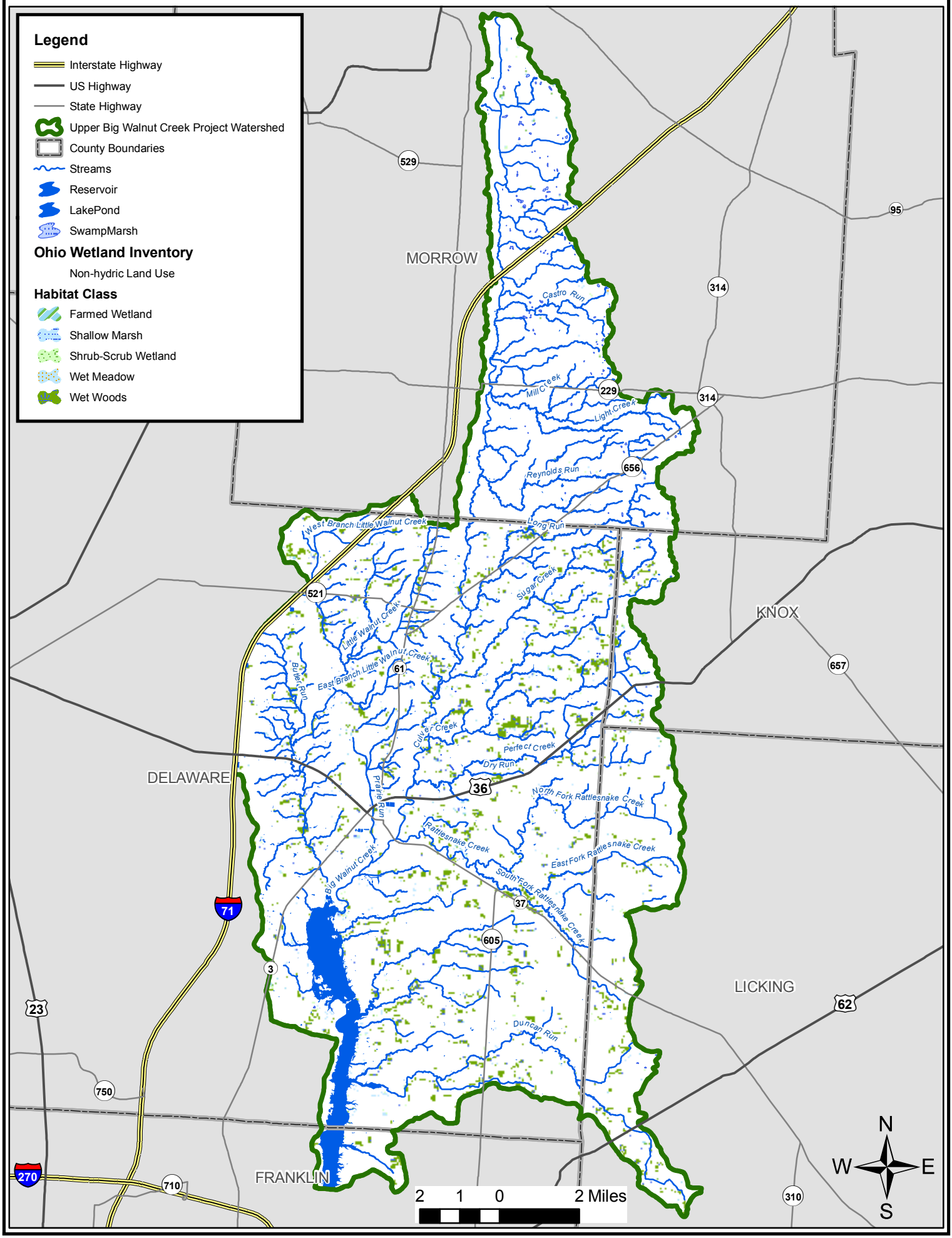
Map 3-9. Soil Drainage Class for Upper Big Walnut Creek Watershed (SSURGO)



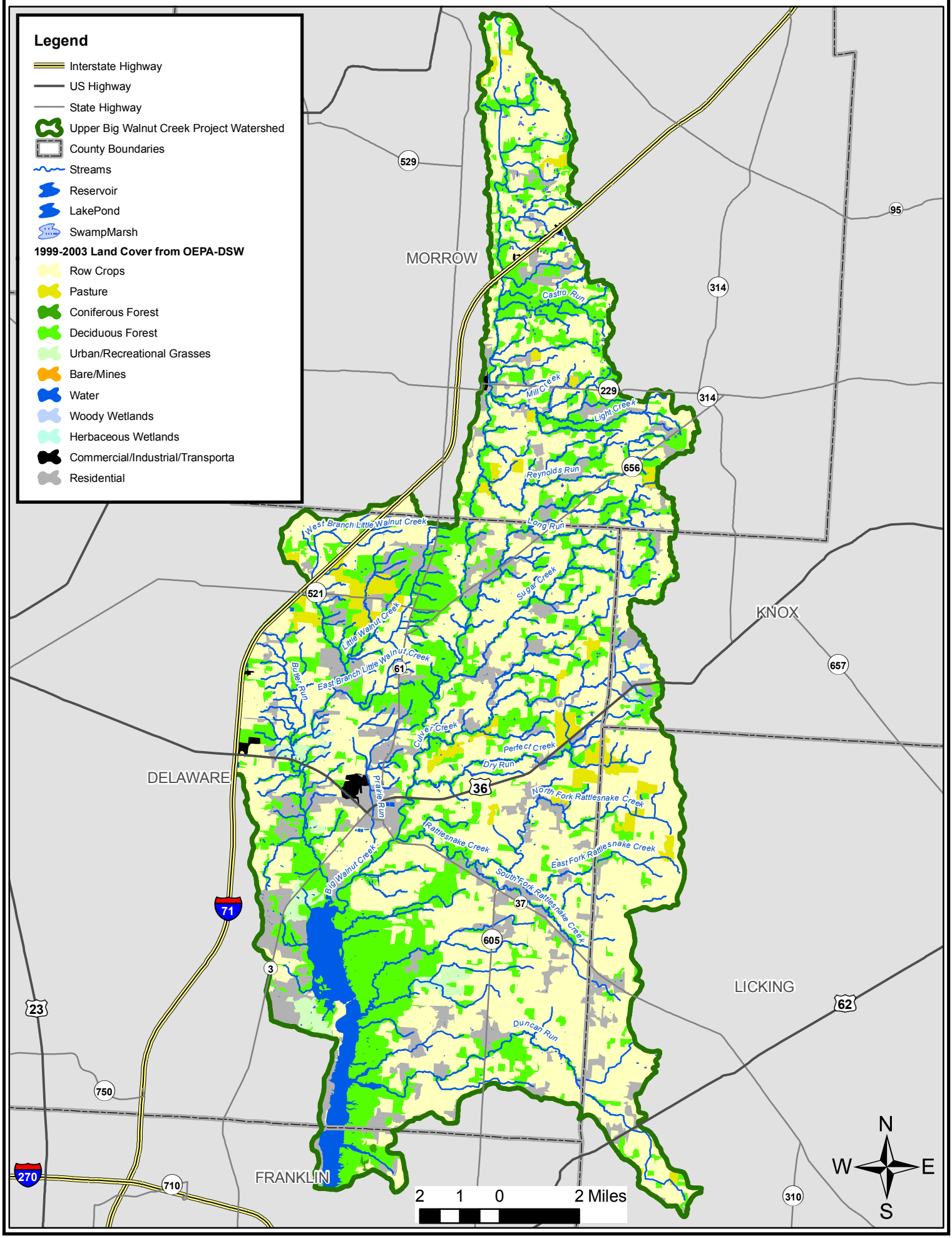
Map 3-10. Ecoregions of Ohio



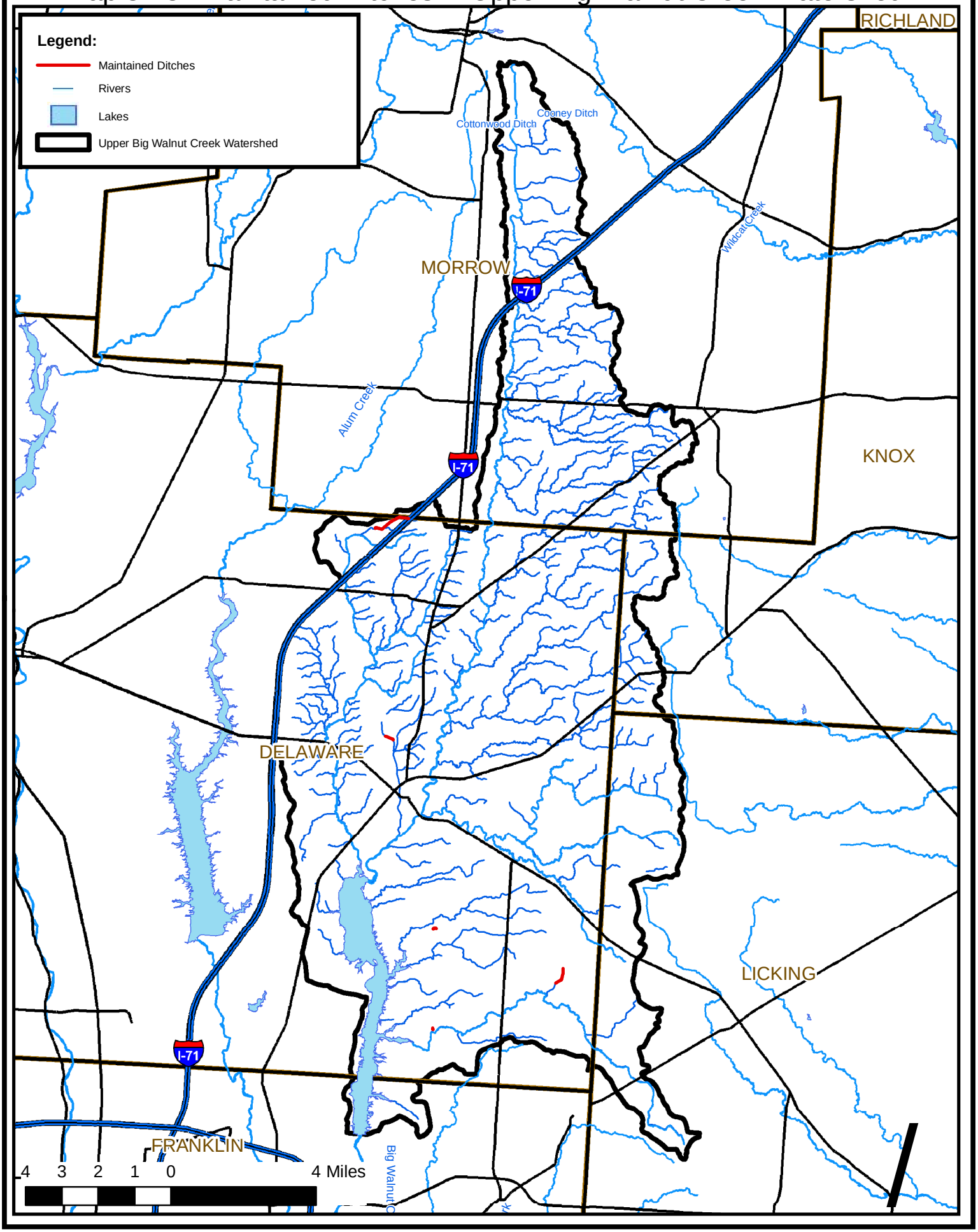
Map 3-11. Ohio Wetland Inventory for Upper Big Walnut Creek Watershed



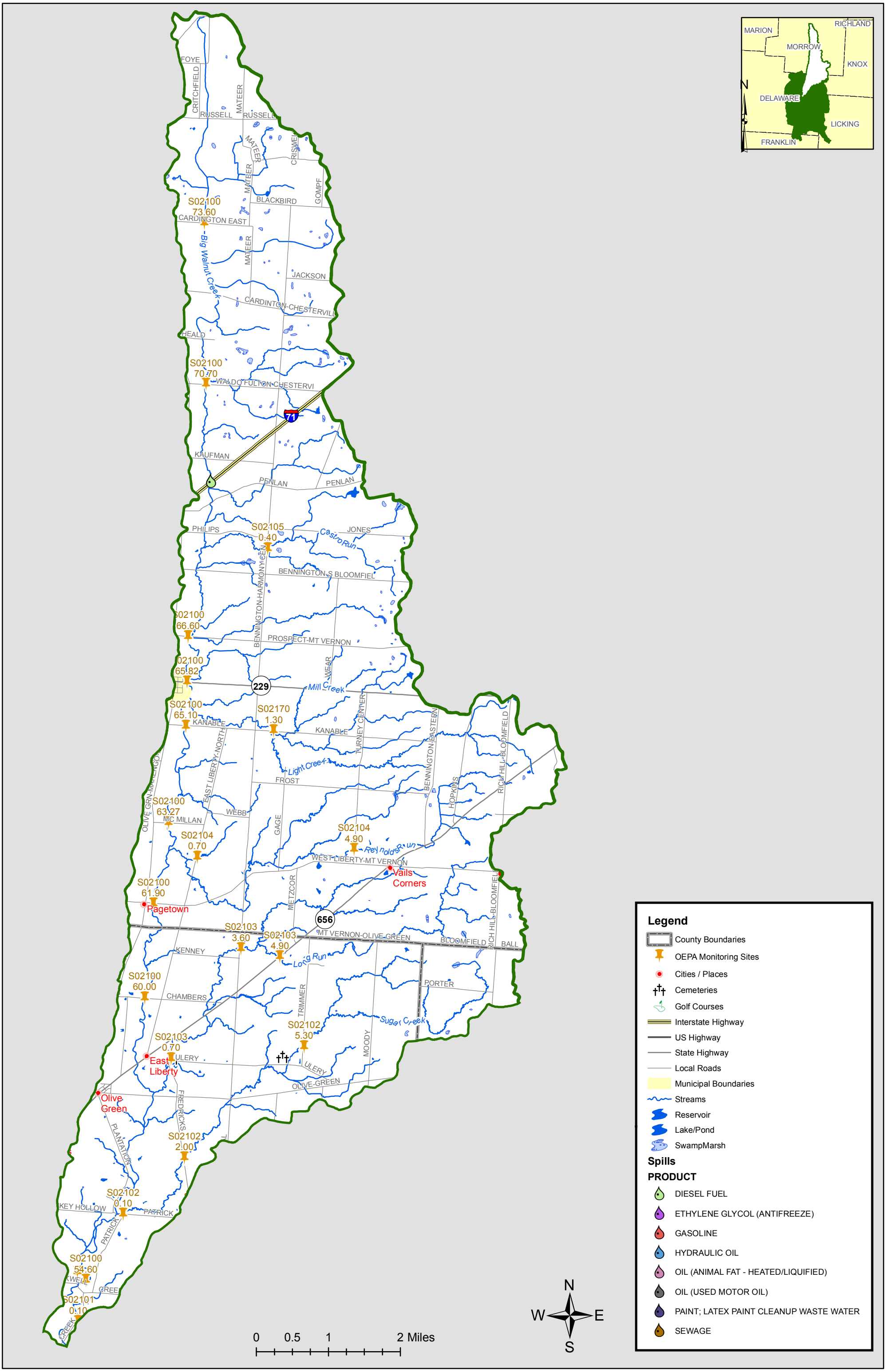
Map 3-12. Land Use Within Upper Big Walnut Creek Watershed



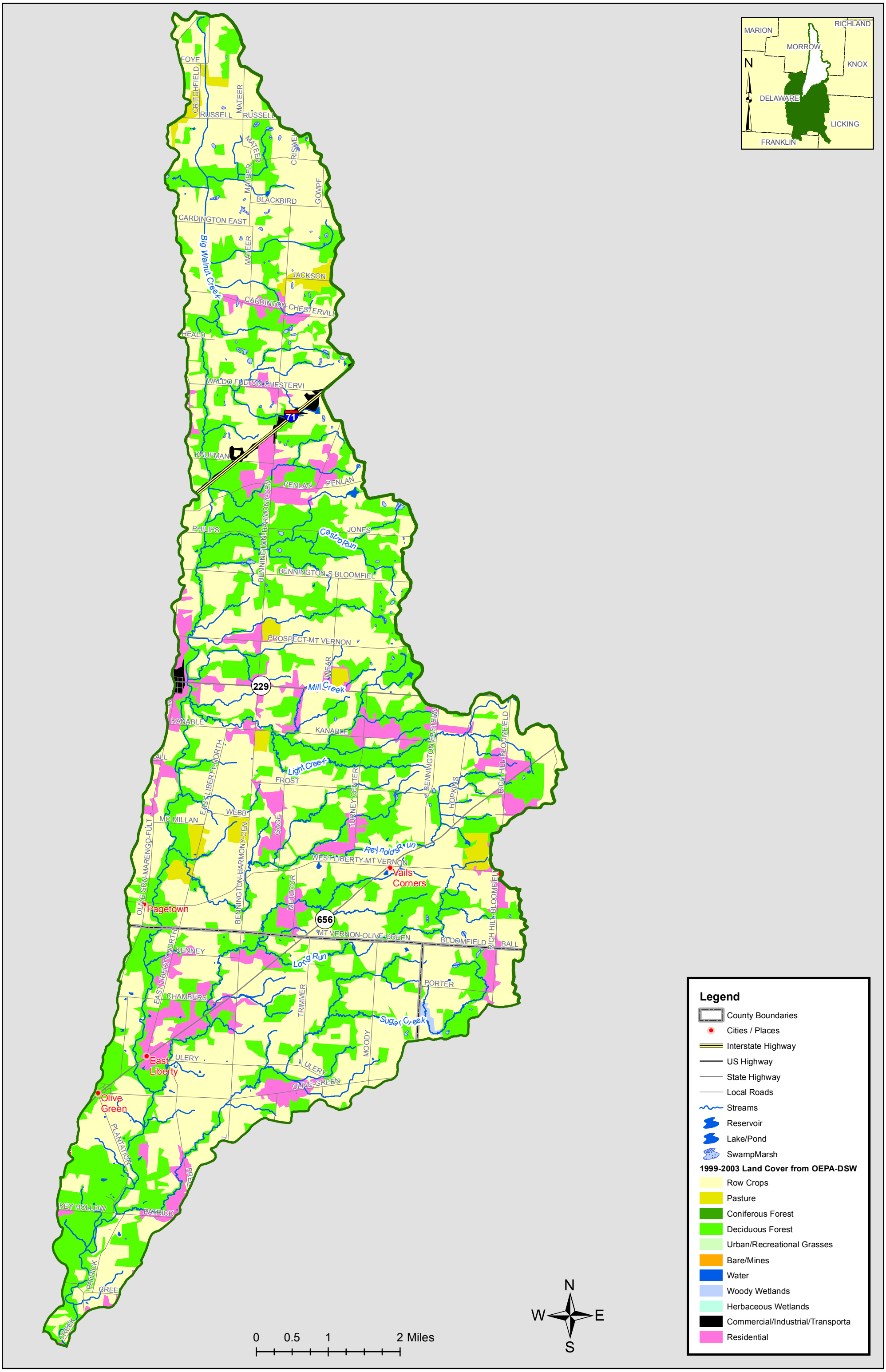
Map 3-13. Maintained Ditches in Upper Big Walnut Creek Watershed



Map 4-1. Overview of Headwaters - Subwatershed 05060001130-010

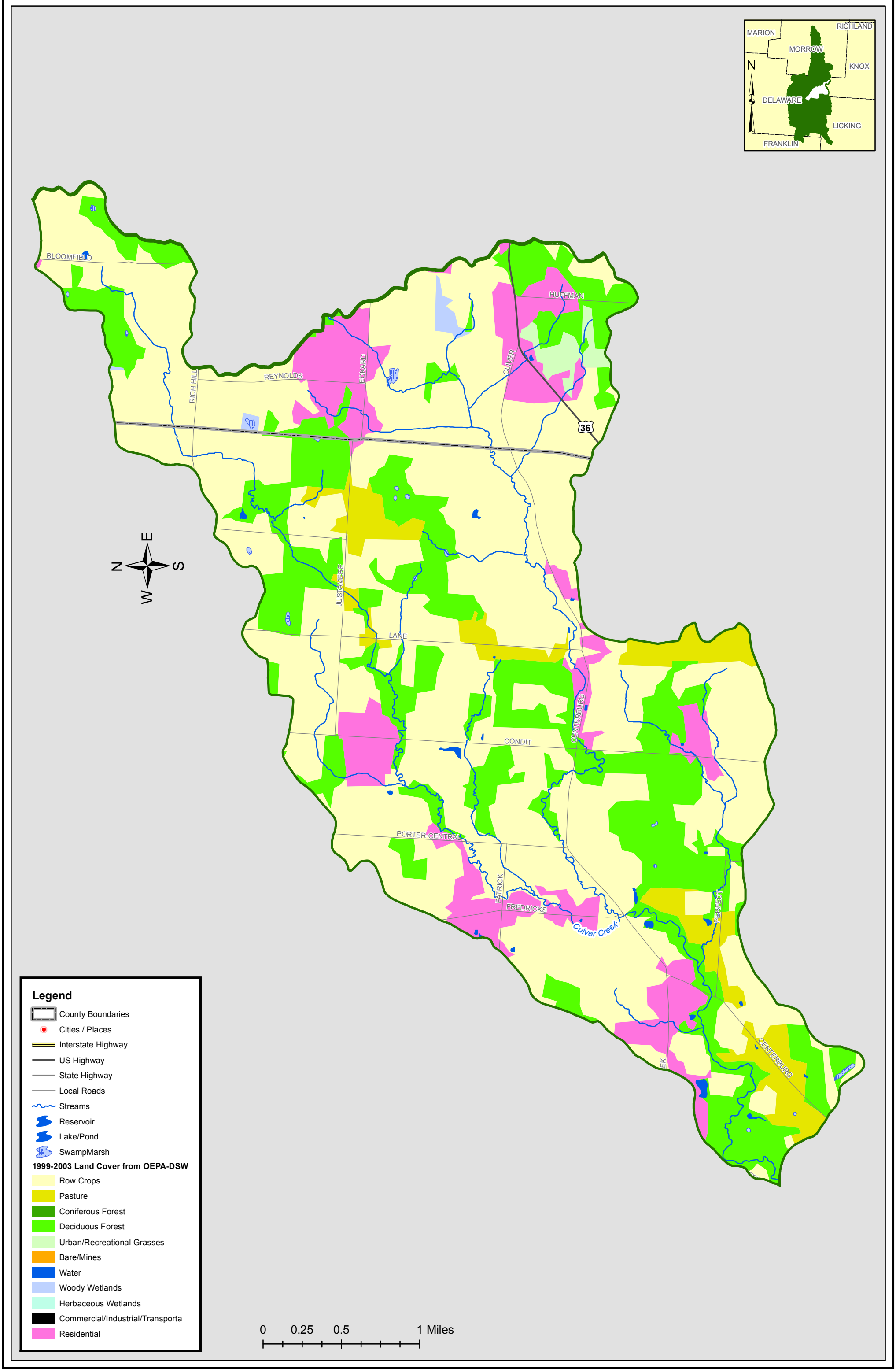


Map 4-2. Land Use 1999-2003 Within Headwaters Subwatershed 05060001130-010

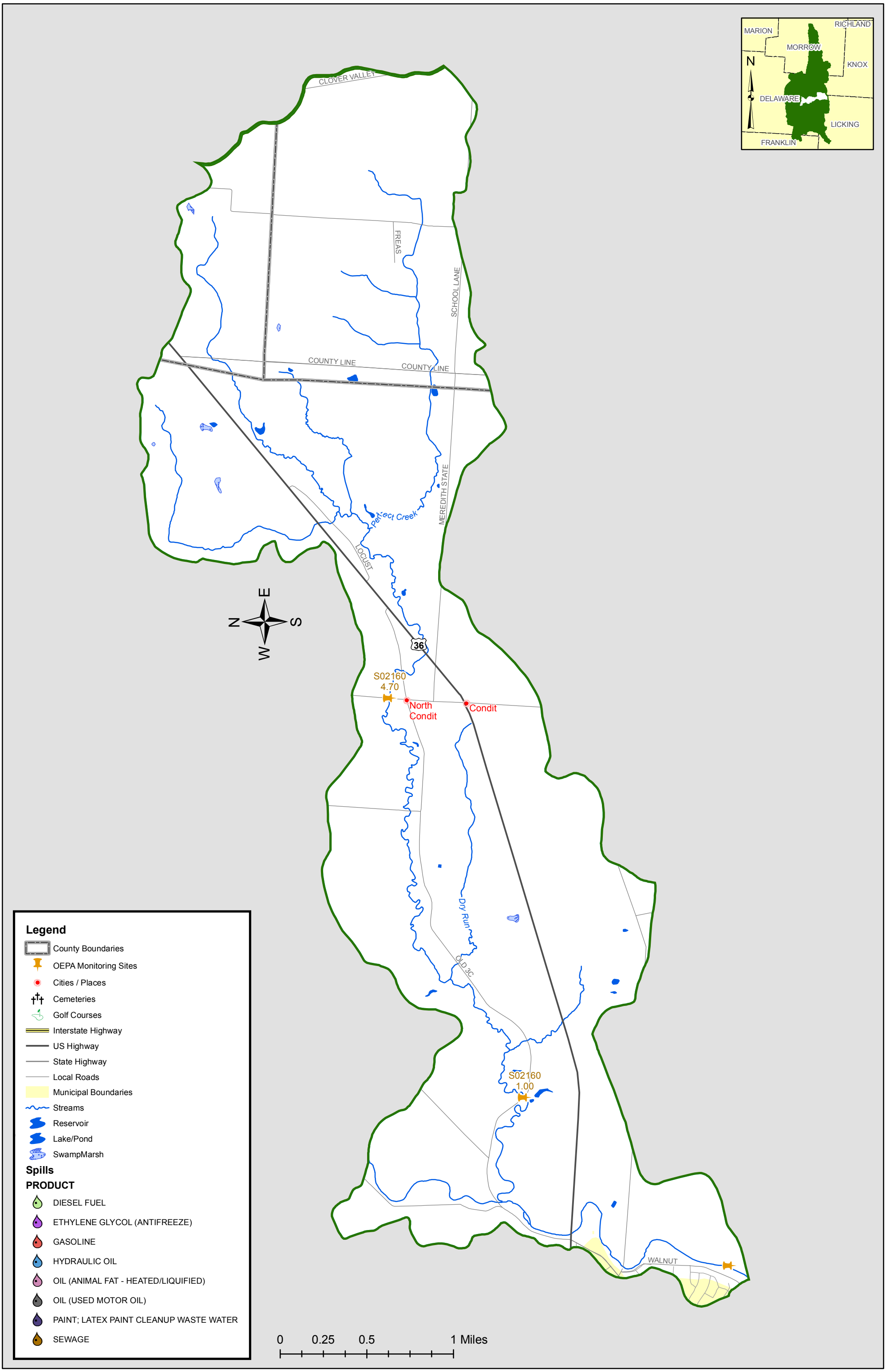


Map 4-3. Overview of Culver Creek Subwatershed 05060001130-020

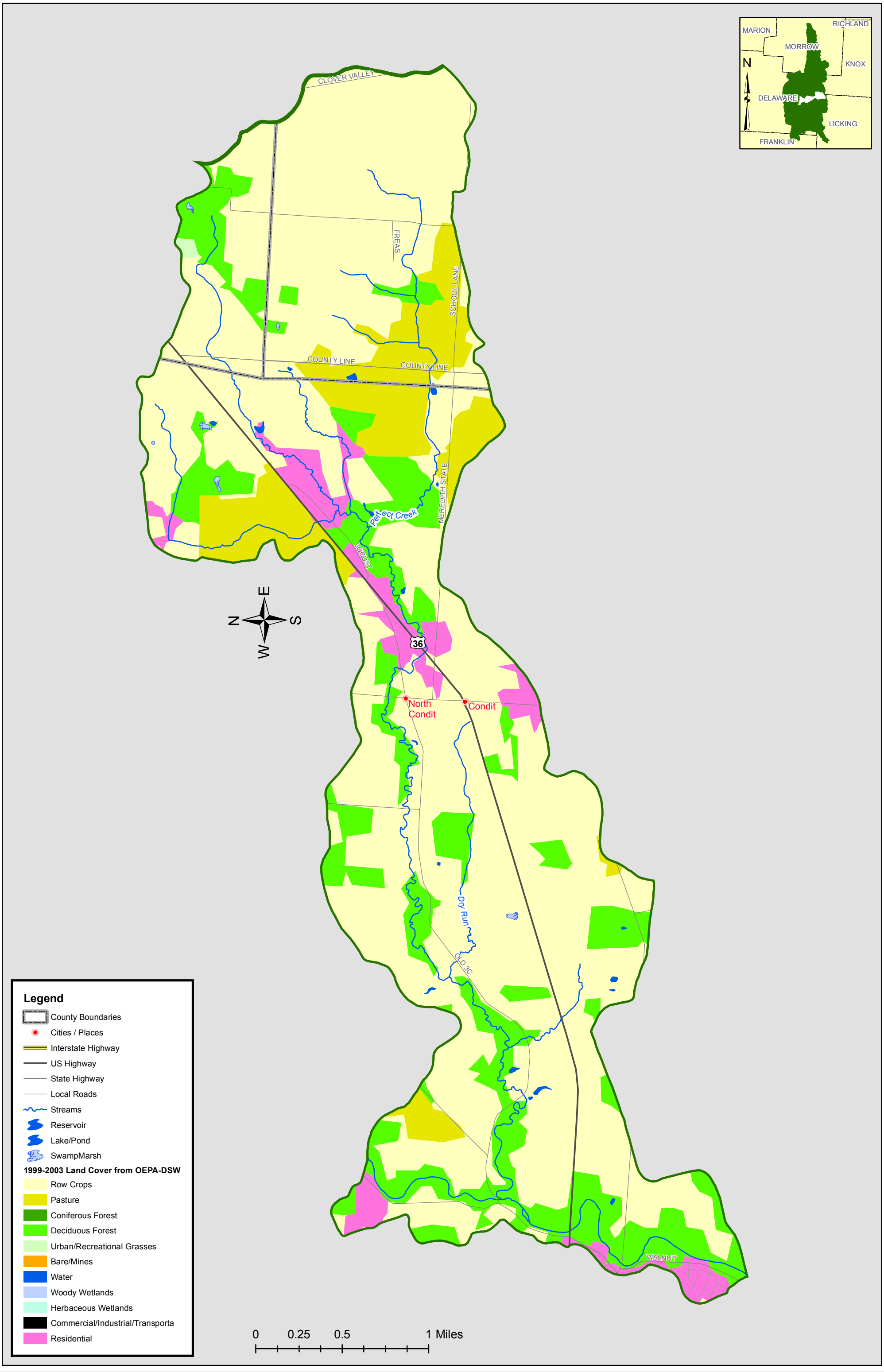
Map 4-4. Land Use 1999-2003 Within Culver Creek Subwatershed 05060001130-020



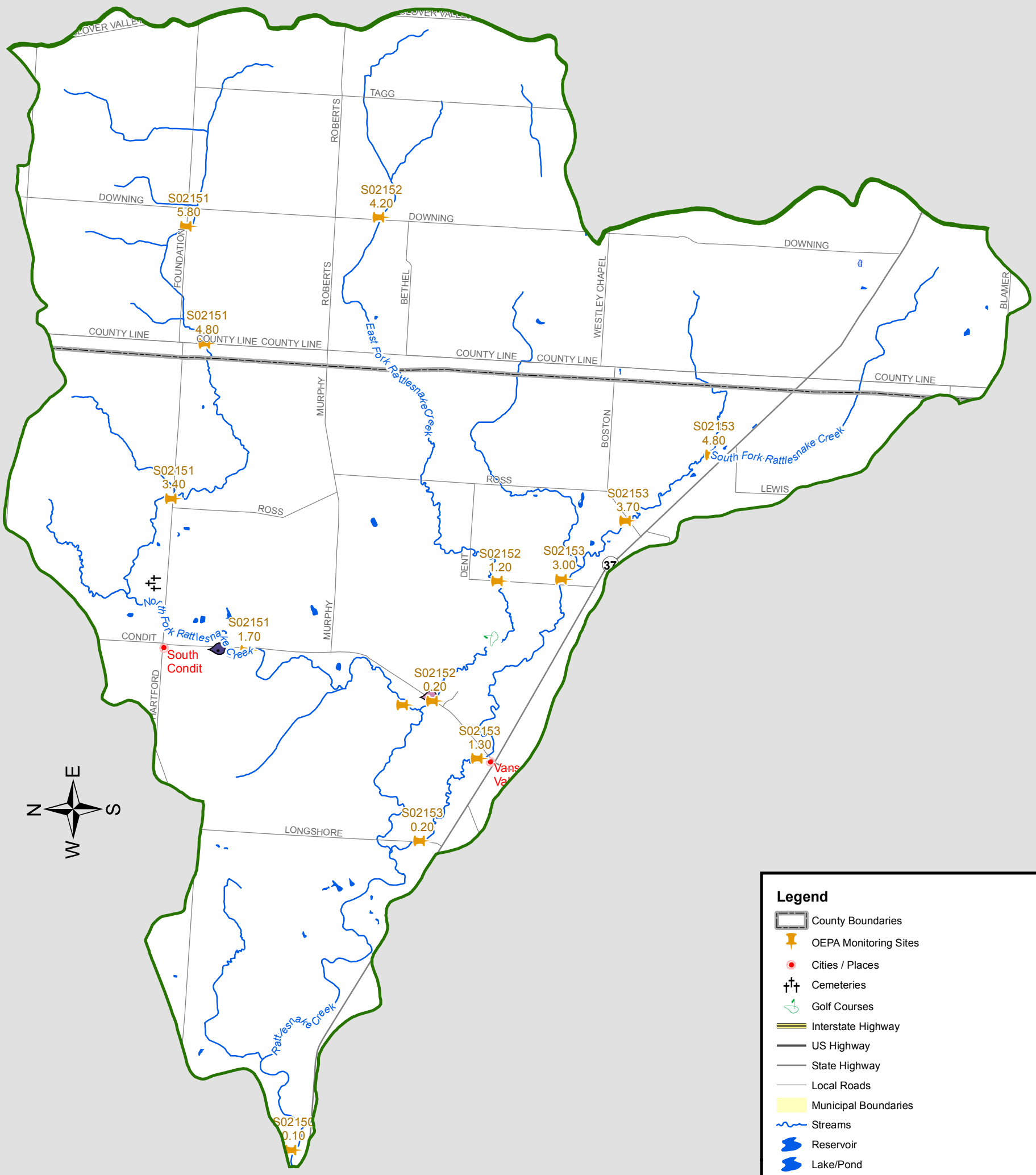
Map 4-5. Overview of Perfect Creek Subwatershed 05060001130-030



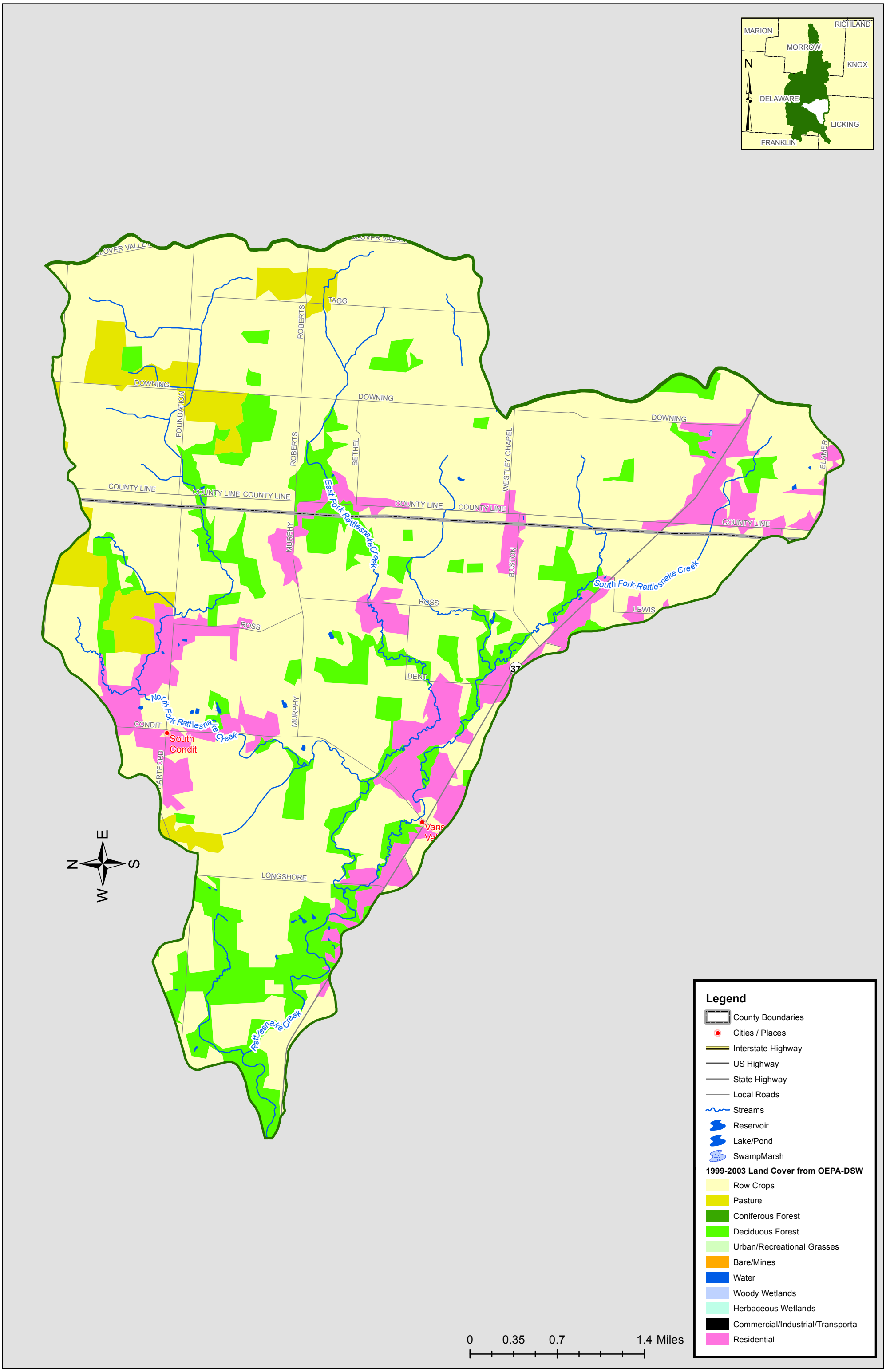
Map 4-6. Land Use 1999-2003 Within Perfect Creek Subwatershed 05060001130-030



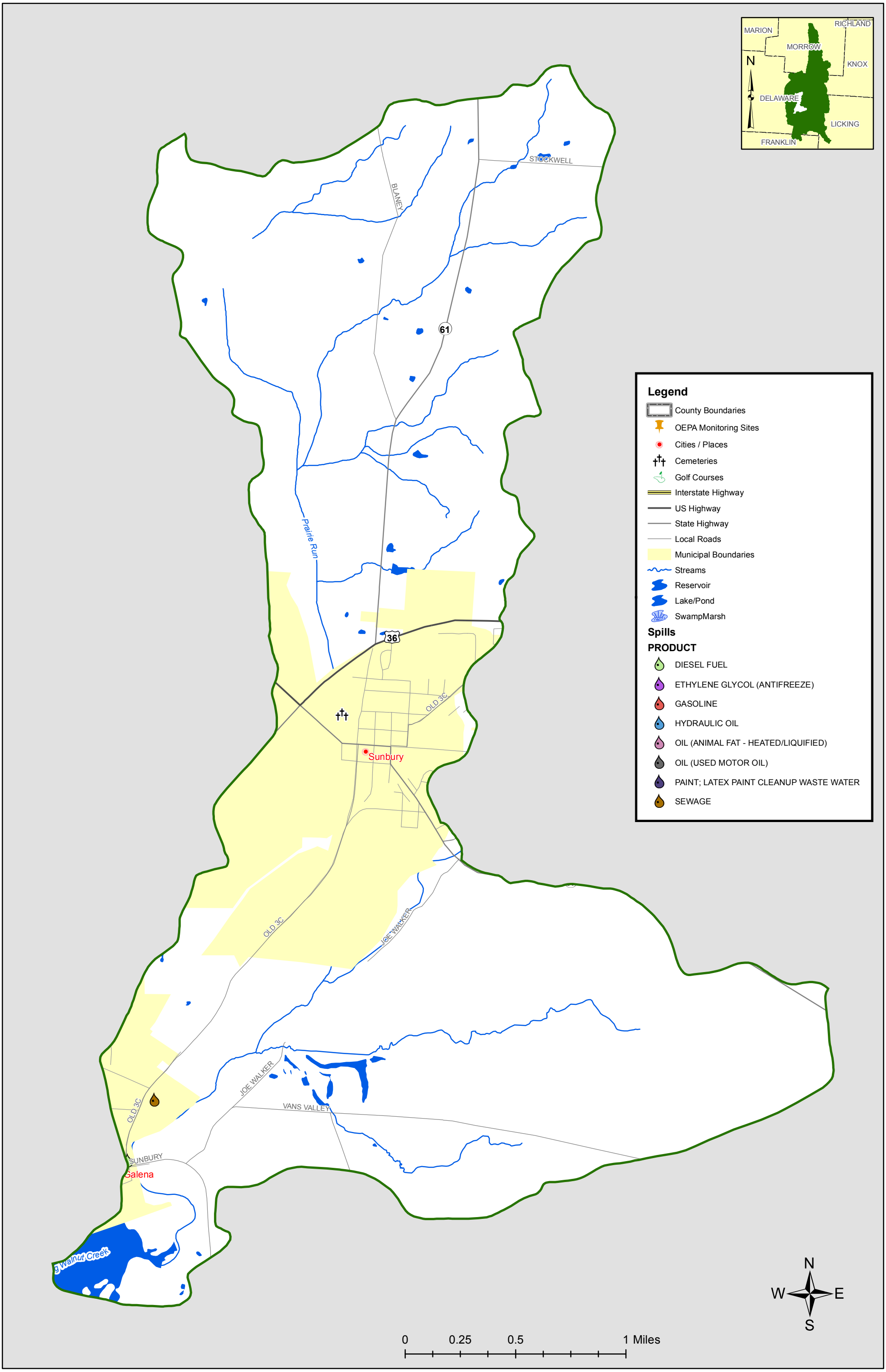
Map 4-7. Overview of Rattlesnake Creek Subwatershed 05060001130-040



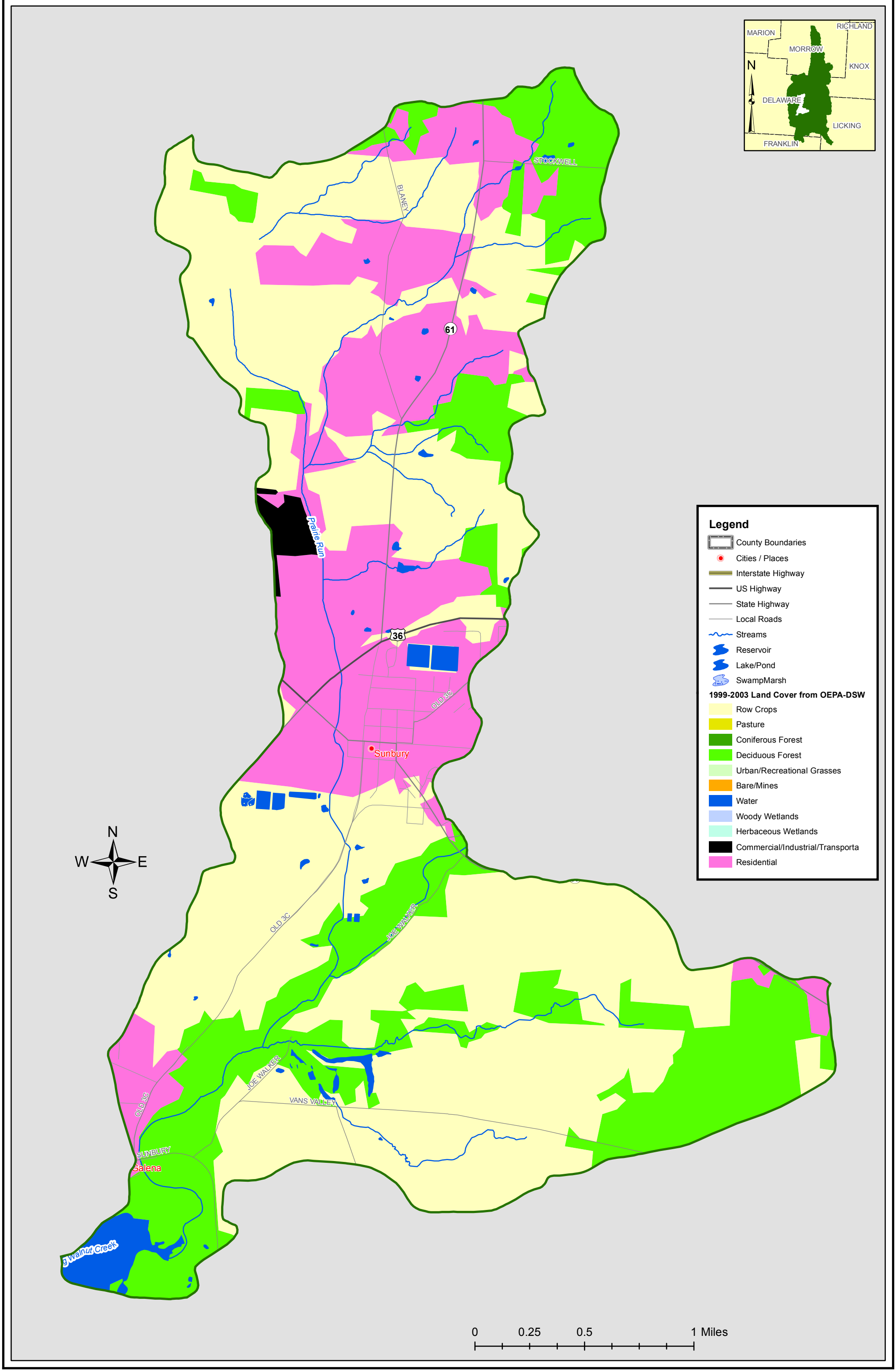
Map 4-8. Land Use 1999-2003 Within Rattlesnake Creek Subwatershed 05060001130-040



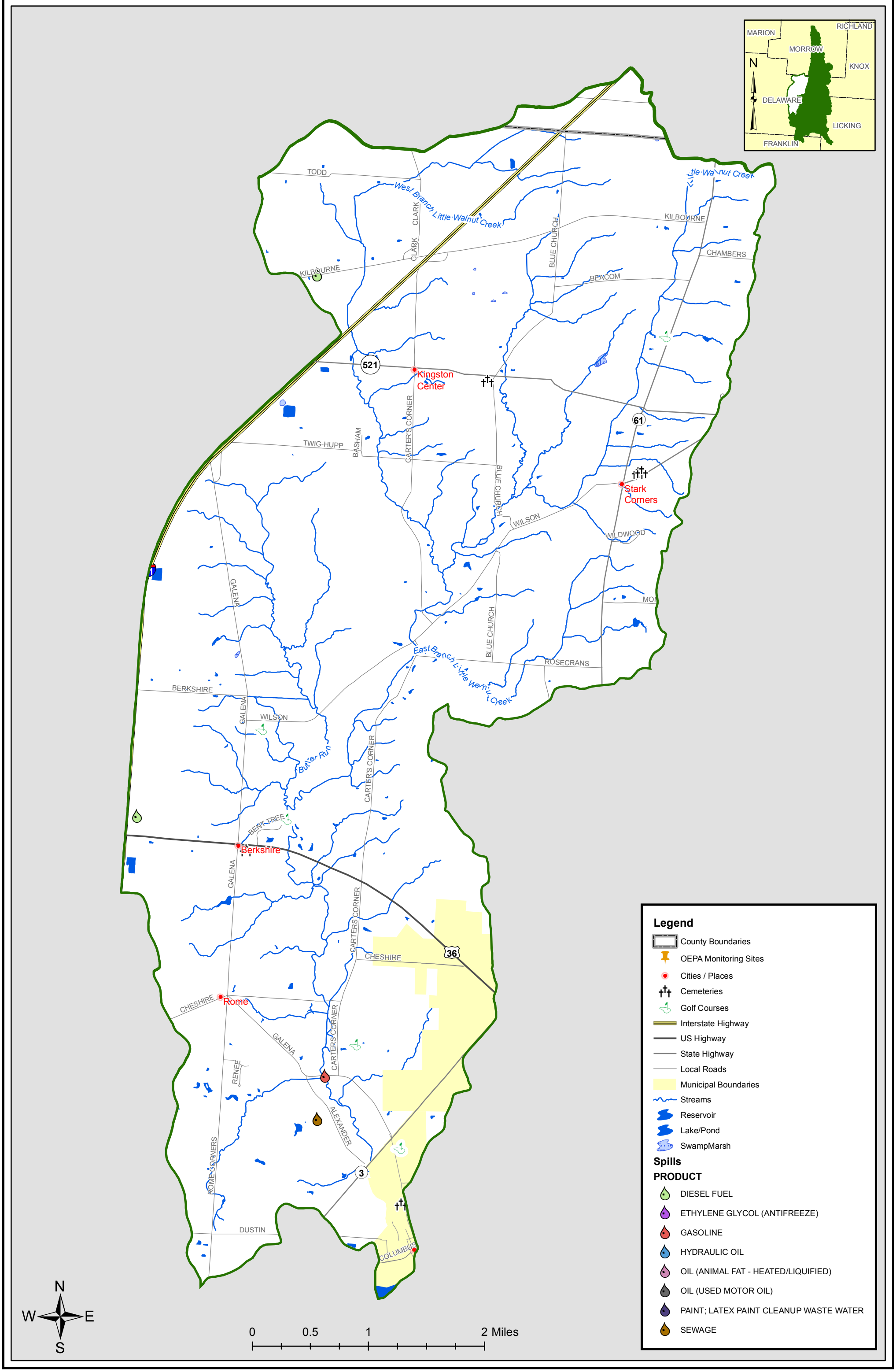
Map 4-9. Overview of Prairie Run Subwatershed 05060001130-050



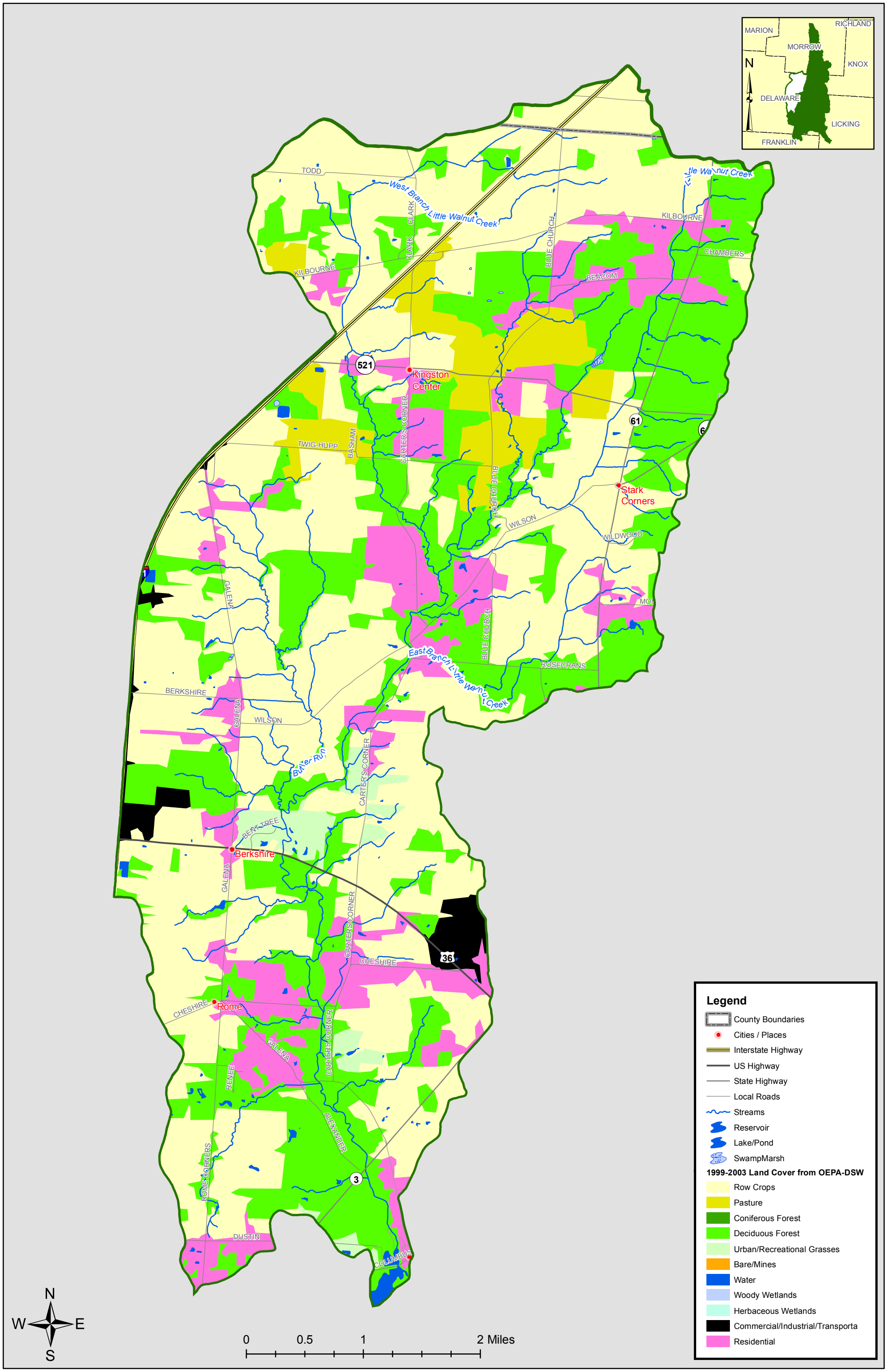
Map 4-10. Land Use 1999-2003 Within Prairie Run Subwatershed 05060001130-050



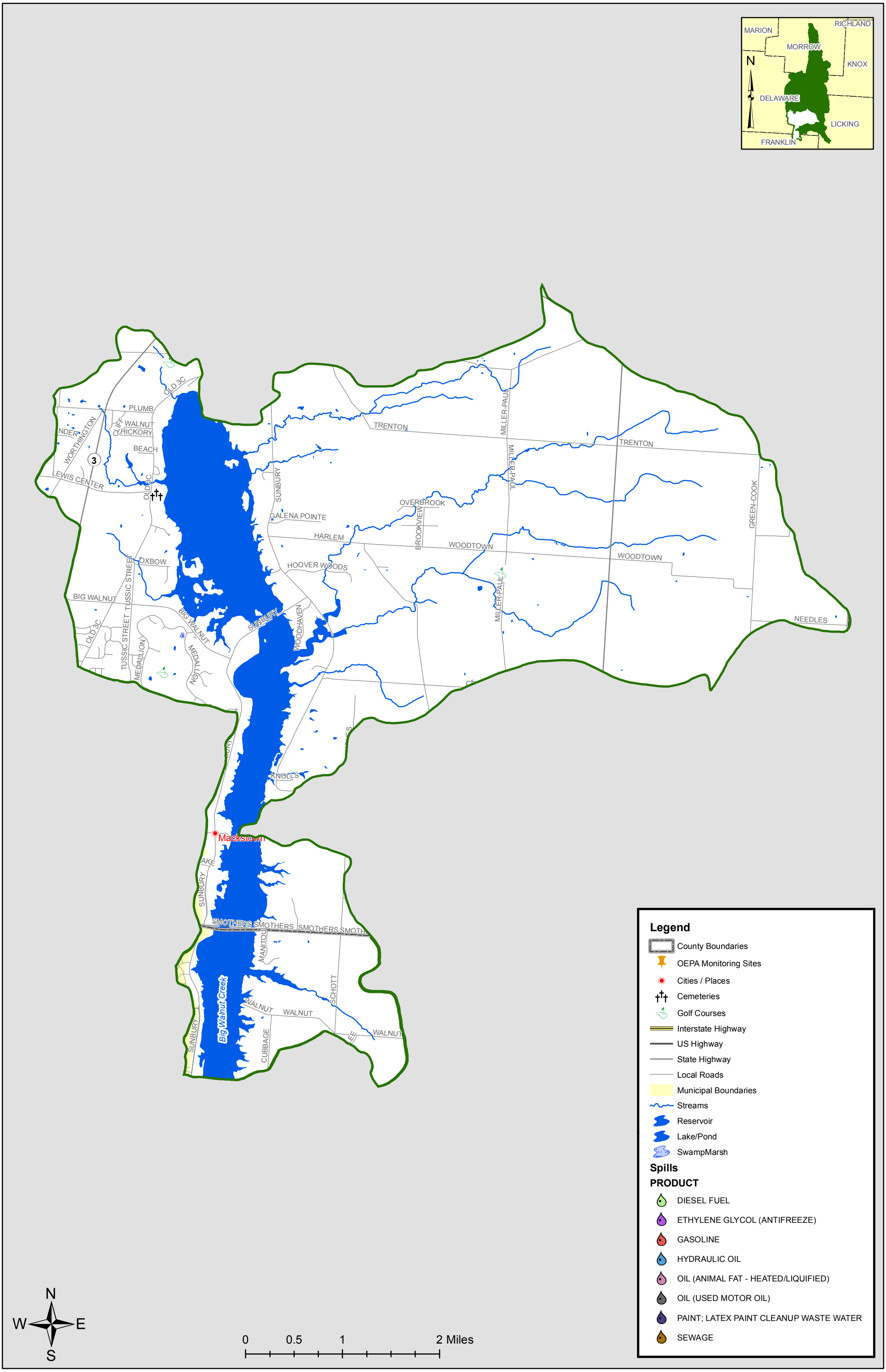
Map 4-11. Overview of Little Walnut Creek Subwatershed 05060001130-060



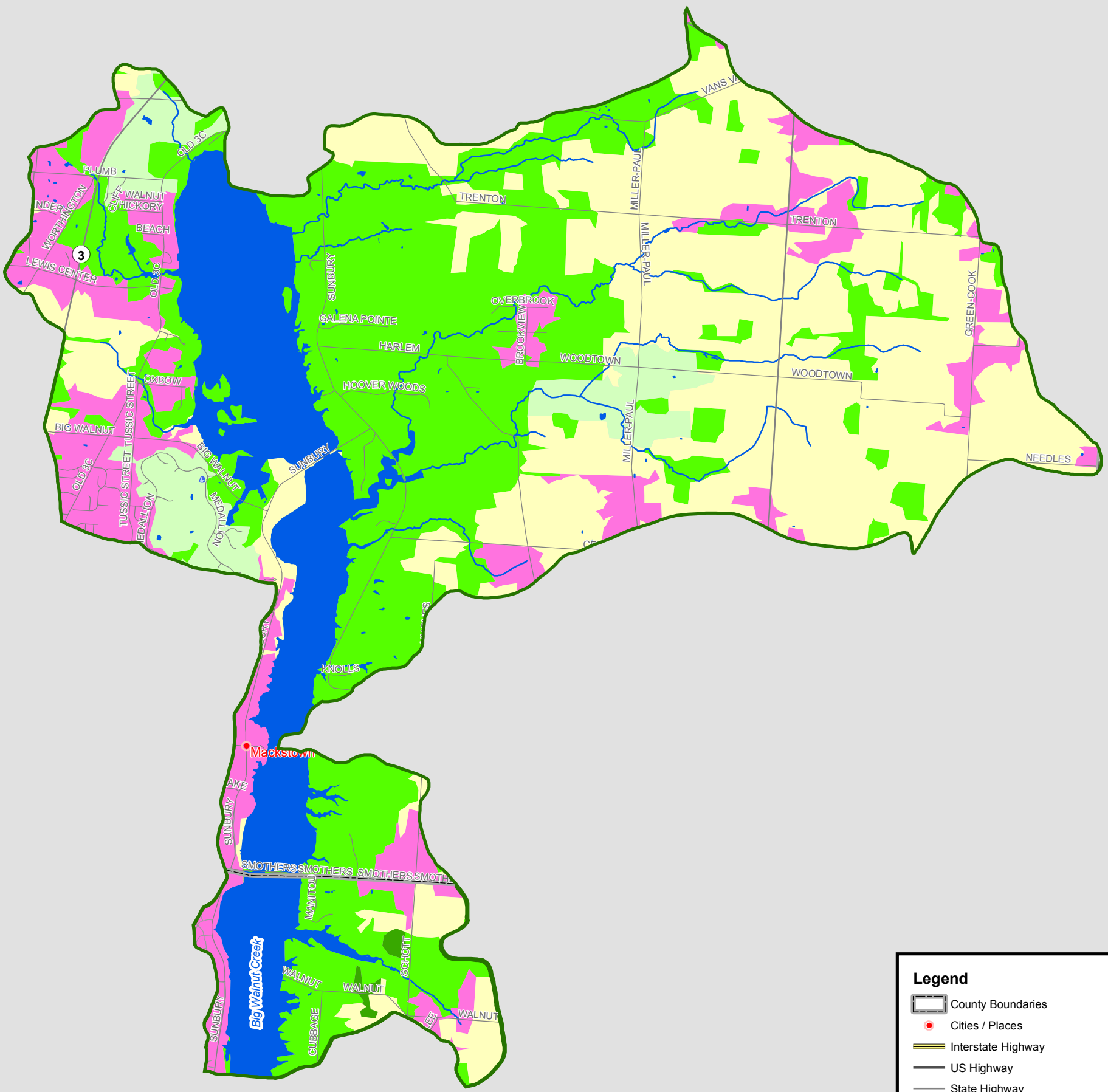
Map 4-12. Land Use 1999-2003 Within Little Walnut Creek Subwatershed 05060001130-060



Map 4-13. Overview of Big Walnut Creek below Little Walnut Creek to above Hoover Reservoir Subwatershed 05060001130-070



Map 4-14. Land Use 1999-2003 Within Big Walnut Creek below Little Walnut Creek to above Hoover Reservoir Subwatershed 05060001130-070



Legend

- County Boundaries
- Cities / Places
- Interstate Highway
- US Highway
- State Highway
- Local Roads
- Streams
- Reservoir
- Lake/Pond
- SwampMarsh

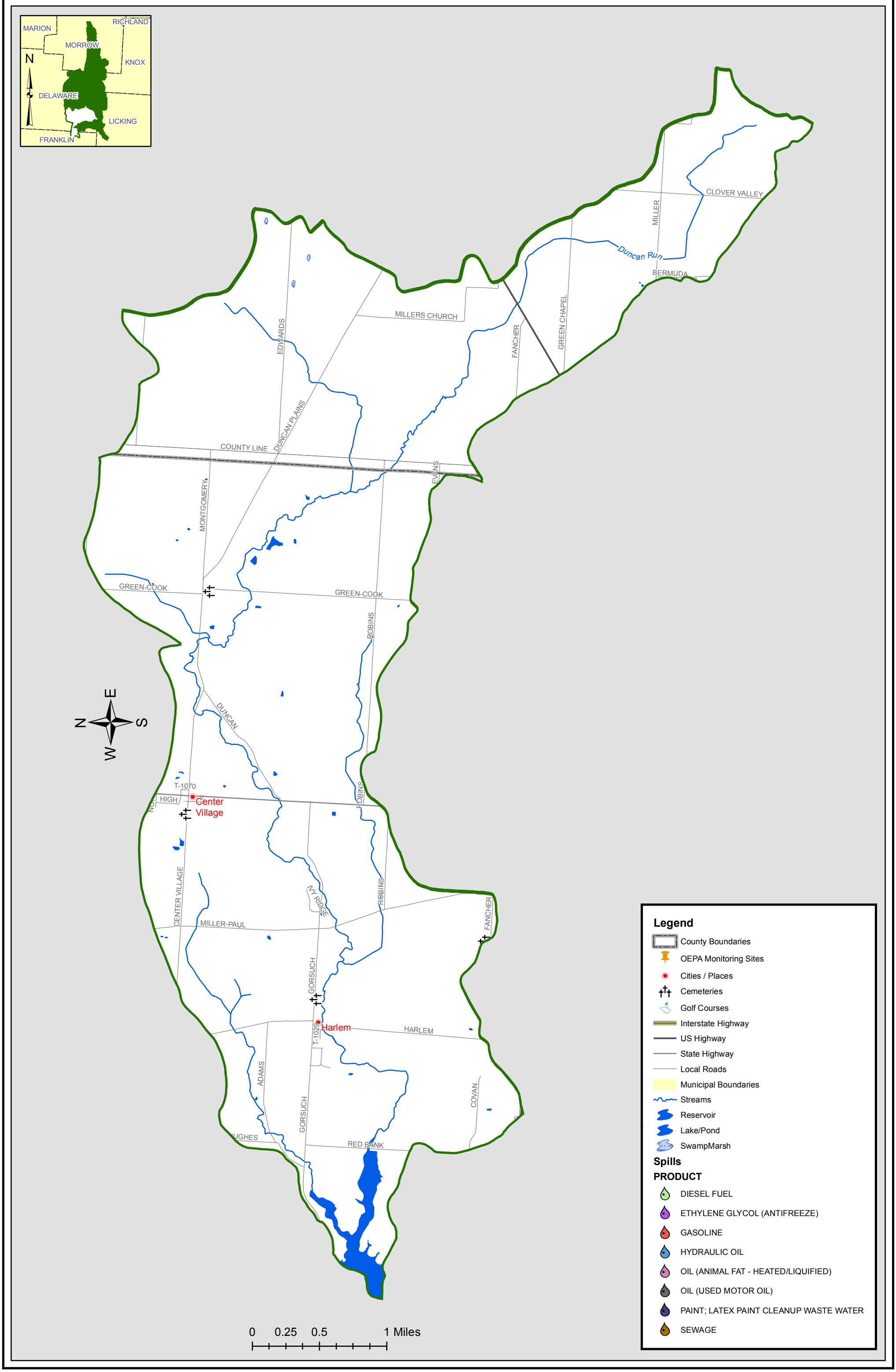
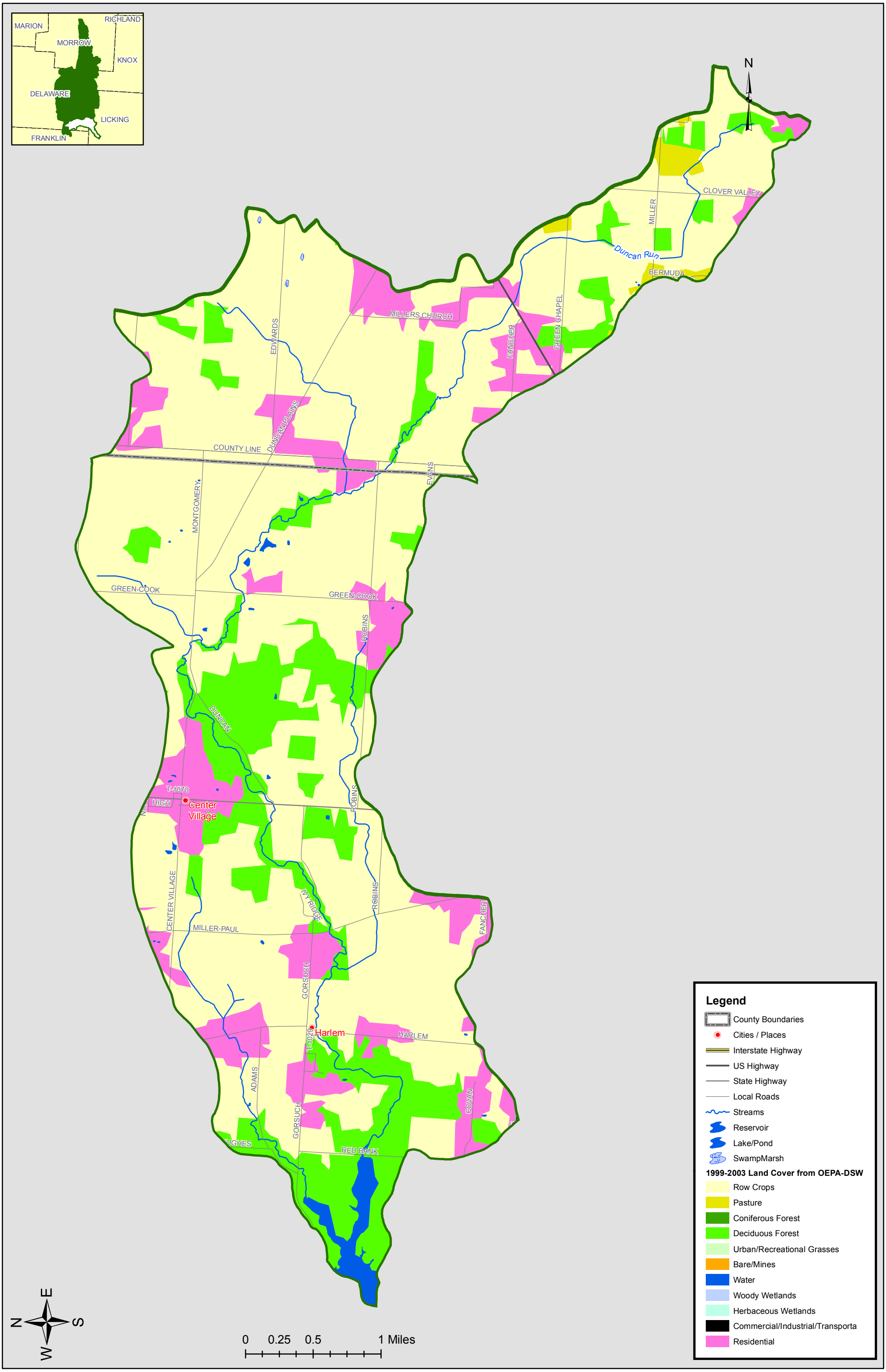
1999-2003 Land Cover from OEPA-DSW

- Row Crops
- Pasture
- Coniferous Forest
- Deciduous Forest
- Urban/Recreational Grasses
- Bare/Mines
- Water
- Woody Wetlands
- Herbaceous Wetlands
- Commercial/Industrial/Transporta
- Residential

N W E S

0 0.5 1 2 Miles

Map 4-15. Overview of Duncan Run Subwatershed 05060001130-080



Map 4-16. Land Use 1999-2003 Within Duncan Run Subwatershed 05060001130-080