Hay Creek Watershed Conservation Management Plan

June 2004

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I. PROJECT AREA CHARACTERISTICS

A. Location

Hay Creek watershed is located in south-central Berks County, Pennsylvania. From its origin in Robeson Township, Hay Creek flows in a northeasterly direction 12.8 miles to its confluence with the Schuylkill River in Birdsboro.

B. Watershed Size

Hay Creek watershed drains a 22.1 square-mile area. The majority of the watershed lies in Robeson and Union Townships, but also drains small portions of Brecknock and Caernarvon Townships, as well as, the boroughs of New Morgan and Birdsboro.

TABLE 1. Municipalities in Hay Creek Watershed

Municipality	Total Area	Watershed Area	Percent in Watershed
	(Miles^2)	(Miles^2)	(%)
Borough of Birdsboro	1.34	0.59	44
Borough of New Morgan	5.74	2.82	49.1
Brecknock Township	17.76	0.11	0.6
Caernarvon Township	8.90	0.13	1.5
Robeson Township	34.32	14.31	41.7
Union Township	23.25	4.15	17.9
Watershed Totals	91.31	22.11	

C. Topography and Physiographic Provinces

Hay Creek Watershed falls entirely within the Gettysburg-Newark Lowland Section of the Piedmont Province. The elevation ranges from approximately 1,000 feet above sea level at Williams Hill in French Creek State Park to 160 feet above sea level where Hay Creek enters the Schuylkill River.

The Gettysburg-Newark Lowland Section consists mainly of rolling low hills and valleys of red sedimentary rock. There are also isolated higher hills developed on diabase, metamorphic rock (hornfels), and conglomerates. Almost all of the underlying sedimentary rock dips to the north or northwest and many of the smaller drainage ways are oriented perpendicular to the direction of the dip so that some of the topography has a northeast-southwest linearity. However, the basic drainage pattern is dendritic. Hay Creek Basin includes trap rock/conglomerate uplands and the Triassic lowlands. Soils are usually red and often have a striking contrast to the green of the vegetation. Relief is generally 100 to 200 feet, but may reach 600 feet on some of the isolated hills.
The basin drains both public and private lands that include a mixture of woodlands, active agriculture, old fields, single-family residences in suburban settings, and urban areas.

Historically, quarries and mines existed within the watershed. Near Birdsboro, the former Benjamin Pupeck quarry site has recently been reactivated as Birdsboro Materials Quarry.

Dam remnant from early industry

Hay Creek Watershed is mapped topographically in USGS 7.5 Minute Series Quadrangles: Birdsboro, Elverson, and Morgantown. These maps depict the headwaters originating at 400 to 1000 feet elevation.

D. Major Tributaries

There are thirteen tributaries of Hay Creek. The largest, Beaver Run, is 3.3 miles in length and drains 3.8 square miles. Its headwaters are near Plowville in Robeson Township and the stream flows through a narrow valley, paralleling the Horse Shoe Trail in places, and tumbles into the Hay Creek near Scarlet's Mill, the former White Bear Station. Beaver Run was designated as HQ-CWF and supports migratory fishes. Morris Run and Cold Run flow into Hay Creek in the upper reaches of the stream. One unnamed tributary that originates at Joanna Heights joins Cold Run at Mill Road in Geigertown. Another tributary, originating near the Geigertown Fire Tower, flows approximately 1800 feet before reinforcing the main branch of the Hay Creek. Indian Run and Stinson Run are dammed for water supply, and join Hay Creek in its lower reaches. Indian Run was also known as Indian Hell Creek (1862 Atlas) and as Engine Run (1876 Atlas). The remaining tributaries are unnamed.

The damming of Indian Run and Stinson run created the Indian Run and Stinson Run Reservoirs respectively. These reservoirs and the former Dyers Quarry pit at Trap Rock are sources of potable water for the Birdsboro Municipal Water Authority. The Authority maintains all three areas, and also has an intake directly from Hay Creek. Additionally, the BMWA owns and maintains approximately 1800-forested acres as the source of public drinking water adjacent to the closed section of Route 82. The Indian Run drainage area, which consists of mature woodland, is 0.82 square miles, or 523 acres. The Haines and Kibblehouse quarry operation, known as the Birdsboro Materials Quarry, is located on Chestnut Hill in the next valley to the north, downstream from the Indian Run reservoir.

Stream order is a "measure of the position of a stream in the hierarchy of tributaries," (Leopold 1994). Relative size and location of a stream within a watershed drainage network can be expressed as a numerical value known as stream order. The smallest streams that have no tributaries are called first order streams. When two first order streams flow together, the stream becomes a second order stream. Second order streams have only first-order streams as

tributaries. This basic pattern is repeated to obtain the highest order stream in the drainage network. As the order of the stream increases, flow and velocity both increase, while channel gradient decreases. Channel dimensions (width and depth) also increase with stream order, as the channel accommodates the increased flow. (Schuylkill Watershed Conservation Plan, 2001).

First order streams enter Indian Run

Beaver Run is a second order stream. Tributaries to Beaver Run are classified as first order streams. Beaver Run flows into the larger Hay Creek, a third order stream. Hay Creek flows into the Schuylkill River, which flows into the Delaware River. At its mouth, the Schuylkill River is a seventh order stream.

1. Stream Classification

In Pennsylvania, streams or stream reaches are classified under water quality standards regulated by the Pennsylvania Department of Environmental Protection. There are five protected use designations awarded to streams that support the maintenance and propagation of fish species and suitable habitat for flora and fauna. The two highest designations, High Quality (HQ) and Exceptional Value (EV) mandate special water quality protection, as they embody outstanding ecological resources that are required to be maintained at existing quality.

Hay Creek and its tributaries have achieved high rankings for water quality. Two reaches of the stream are classified EV, the highest designation, reserved for the most pristine waters in the state. These are: from the source to unnamed tributary 63882 at River Mile 8.1 and from Beaver Run to the Birdsboro boundary. Beaver Run is designated as HQ waters-cold water and migratory fisheries.

Springs along Furnace Road

Part of the Hay Creek's main stem, and all other major tributaries, are rated Cold Water Fisheries (CWF), which support trout and native flora and fauna in a cold-water habitat and Migratory Fisheries (MF), which support the passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle. Table 2 identifies stream classifications in the Hay Creek Watershed.

TABLE 2. Stream Order and Classifications in the Hay Creek Watershed

Stream	Zone	Classification	Order	Exceptions
Hay Creek	Basin, Source to UNT 63882 at River Mile 8.1	EV	3	None
UNT 63882 TO HAY CRK.	Basin	CWF, MF	2	None
Hay Creek	Basin, UNT 63882 to Beaver Run	CWF, MF	3	None
Beaver Run	Basin	HQ-CWF, MF	2	None
Hay Creek	Basin, Beaver Run to Birdsboro Boundary	EV	3	None
Hay Creek	Basin, Birdsboro Boundary to Mouth	CWF, MF	3	None

Dyers Quarry at Trap Rock

E. Stream Corridor

The stream corridor includes the stream and adjacent land running along the stream. Stream characteristics and water quality are greatly dependent upon the natural features of this land, as well as the modifications that have occurred over time. The headwaters are mostly forested with narrow steep valleys. The mid section runs through a wider valley supporting residential areas and agriculture. The next downstream section runs through mixed wooded, residential and former iron industry sites. This section continues along Route 82 passes by the Birdsboro Material Quarry and then along Rustic Park. The Creek then travels through Birdsboro with high-density housing and flows into the Schuylkill after passing under Route 422.

Birdsboro Materials Quarry

1. Land Use

Land cover is determined using satellites, aerial photography with different filters, and a grid system. Each grid is 30 meters by 30 meters. The result can be skewed data, although it balances itself in the larger scenario. For example, in an area where zoning permits one single family dwelling be built on a five acre parcel, and the house is surrounded by woods, the parcel may be considered as mixed forest instead of low density residential. Historically, forests are the dominant form of vegetation in Pennsylvania. The hardwood forests regenerated after being harvested in the 18th and early 19th centuries to supply the charcoal requirements of the colonial iron industry. Approximately 70% of the land along the Hay Creek corridor is in deciduous forest. This is particularly true along the first and second order tributaries. These tributaries comprise the majority of stream length and total corridor area in the watershed.

The main categories of land use in the watershed are forests, agriculture, and open water/wetlands. Residential development, commerce, and industry are also present. The Land Cover Map shows 10,728.51 acres in woodland (75.8%), 2,835.75 acres in farmland (20.1%), 369.10 acres in open water and/or wetlands (2.6%), 158.83 acres in residential development (1.1%), and 54.40 acres in Industrial/Commercial/ Transportation (0.4%). Further breakdown of these use categories for the various regions of Hay Creek may be seen in Table 3.

Agricultural lands are present in those areas where the Hay Creek valley is wider and more open. Pasture, meadows and hay fields embody both active and fallow farms. The largest tract of farm land begins north of New Morgan and parallels the Hay Creek to approximately one mile past Geigertown. Other agricultural areas are located north of Beaver Run, and south of Plowville. Today, in addition to cropland, pastures support cows, sheep, horses and llamas. A boarding and riding stable is located along Buck Hollow Road. There are also tree farms and nurseries.

Indian Run feeder

The patterns of development in the Hay Creek watershed are similar to those in other areas of southeast Pennsylvania, with agricultural tracts of eighteenth century origin, towns and villages from the mid-nineteenth century, and patterns of sprawl emerging in the late 20th century. As we enter the 21st century, growth issues are of critical concern in the watershed.

TABLE 3. Land Coverage by Section				
Watershed	**Upper Hay**	**Beaver Run**	**Lower Hay**	**Hay Total**
Land cover classification	**Acres**	**Acres**	**Acres**	**Percentage**
Deciduous Forest	5,331.85	1,836.15	2,763.22	70.2
Evergreen Forest	182.33	108.36	104.63	2.8
Mixed Forest	216.11	72.52	113.35	2.8
Pasture/Hay	1,949.27	372.96	262.82	18.3
Row Crops	197.64	33.33	19.74	1.8
Transitional	.00	.00	4.32	0
Open Water	173.05	24.40	20.86	1.5
Emergent Herbaceous Wetlands	76.93	10.03	8.34	0.7
Woody Wetlands	34.58	10.63	10.26	0.4
High Intensity Residential	0.54	0	40.50	0.3
Low Intensity Residential	22.56	1.17	94.06	0.8
Commercial/Industrial/ Transportation	21.53	1.62	31.25	0.4

PA Route 82 crossing Schuylkill River to left - Birdsboro center

The area of heaviest population is the Borough of Birdsboro, located along the Schuylkill River. Today most of the developable land in the Borough has been built upon. Haines and Kibblehouse, Inc have proposed a large-scale housing development of almost 300 units in neighboring Union Township. Haines and Kibblehouse applied for the required water and sewer services from the Birdsboro Heights Water Company in 2001.

The Berks County Planning Commission has identified the Hay Creek watershed area for future growth in the County's 20-20 Vision Comprehensive Plan. The following reasons formed the

basis for this decision: 1) The area does not meet the minimum requirement of 500 contiguous farm acres to qualify as a viable agricultural zone in Berks County, 2) The watershed contains an existing village setting and, 3) the local municipalities are considering an infrastructure upgrade.

Borough of Birdsboro

2. Zoning

In June, 2000 Pennsylvania adopted its own "smart growth" legislation amending the Municipalities Planning Code, which gives Pennsylvania's municipalities the authority to regulate land use. These reforms enable counties and municipalities to take more control of their future growth by planning together for both development and conservation of resources, and, most importantly, implementing such plans through cooperative agreements and consistent ordinances and actions. Notably, the Berks County Planning Commission leads the Commonwealth in helping municipalities to develop joint comprehensive plans. To receive funding for the planning process, the local municipalities plans must be consistent with the County's comprehensive plan.

The Berks County Commissioners adopted its updated comprehensive plan, *Berks County Vision 2020* in April 2003. The Berks County Planning Commission, authors of this document, identified the Designated Growth Areas as those regions where infrastructure currently exists, or that have direct access to the sewer. The Future Growth Areas, or expansion area, is where sewers are planned. As a next step, it is hoped that communities will work together to develop joint zoning ordinances.

There are two joint comprehensive plans underway in the Hay Creek Watershed. The municipalities of Robeson, Union, Caernarvon and Birdsboro have banded together to develop the Southern Berks Multi-Municipal Plan. Also, Brecknock Township has joined with the other Governor Mifflin School District municipalities: Cumru, Shillington, Kenhorst, and Mohnton to develop the Governor Mifflin Joint Comprehensive Plan. New Morgan has chosen to remain independent.

Land use ordinances from all the municipalities within the watershed were reviewed. Although there are various different zoning districts contained within the watershed, the majority of land is zoned Rural Residential District (R), because of the rustic nature of the surrounding area. Below is a breakdown of the different zoning districts per municipality. The language is from the respective ordinances.

Grist Mill built by Paul Geiger

House near French Creek State Park

Birdsboro Borough

Zoning designations in the Hay Creek watershed are Residential (R1), (R2), (R3), (R4), (R5), Commercial (C) and Industrial Districts. Industrial lands are near the river and railroads. The Commercial District is located downtown, between Route 724 and Route 82 and extending east.

Brecknock Township

The lands of Brecknock Township in the Hay Creek Watershed are zoned Rural Conservation. Permitted uses allow all forms of agriculture, except intensive agriculture, pursuant to Section 312; single family detached dwellings; municipal use; and communication towers and communication antennas (by conditional use). Brecknock Township has an ordinance to establish density adjustment factors to be utilized to determine total developable area, maximum tract density, and minimum individual lot size for the R-A, R-1, and R-4 Zoning districts.

Caernarvon Township

The broad zoning land use categories for the township are Rural Conservation, Residential (Rural and Suburban), Commercial (Mixed, Neighborhood, and Highway), Industrial (Limited, General, and Office Park), Planned Residential Development and Effective Agriculture Preservation. Only a small portion of Caernarvon is in the Hay Creek Watershed. The western boundary is zoned Rural Conservation (R2) and the eastern boundary is zoned Rural Residential (R3).

The purpose of the Rural Conservation zone is to encourage the preservation of certain rural areas within the Township, in order to conserve such natural features as watercourses, watersheds, and forest areas, and the most suitable farmland within the Township. It is also the purpose of this district to discourage development in areas in which on-site disposal of sewage may be undesirable.

The purpose of the Rural Residential district is to provide areas for low-density residential development and for limited farming activity and other non-residential uses. Caernarvon Township also has a Flood Plain District zoning.

Development near Beaver Run

Development in lower Hay Creek

New Morgan Borough

The areas within the Hay Creek Watershed are zoned Residential (R), General Commercial (GC), and Industrial (I) Districts. The purpose of the Residential District is to provide area for a wide array of residential development depending upon the availability of adequate water supplies and sewage disposal facilities. Flexibility in the design of planned residential developments is encouraged. Among the permitted uses are: single family detached dwellings; apartment buildings and townhouses; condominiums, semi-detached units; fire and police stations; libraries and post offices. The Residential Zone supports the creation of many kinds of recreation areas. The purpose of the General Commercial zone is to provide for a mixing of commercial and residential uses in specific areas.

The purpose of the Industrial District is to provide an area in which a variety of industrial uses may locate provided that they will not adversely affect the public health, safety and welfare nor degrade the environment.

Robeson Township

The majority of the land in the Hay Creek watershed is zoned as a Rural Residential District. The purpose of this District shall be to encourage the preservation of rural areas containing woodlands, stream headwater areas, surface water, agricultural lands, and wildlife habitats, thereby perpetuating the rural character of the Township. Intensive residential development shall be discouraged where there are steep slopes and woodlands.

The second highest amount of land is zoned as Low Density Residential Districts. The purpose of this District shall be to facilitate residential development areas, which, although generally rural in character, are currently developed for residential use. These areas typically exhibit fewer constraints to development than the lands in the R: Rural Residential District.

The third highest acreage is zoned as an Agricultural District. The new zone, adopted March 18, 2003, includes sections of the areas noted as Pasture/Hay on the Land Cover map, north of Beaver Run and the area adjacent to Caernarvon Township to the northeast, at Red Hill Road. These areas were previously zoned as Rural Residential.

Other zoning districts contained within the Hay Creek watershed are GIA: General Industrial (A) District, GC: General Commercial District, LI: Light Industrial District, HDR: High Density

Residential District, and Q: Quarry District. Most of these districts are small, especially in comparison to the Rural Residential District.

TABLE 4. Housing Units and Subdivision Plans

MUNICIPALITY		HOUSING				SUBDIVISONS			
	Housing	Housing	%	Plans	Housing	Acres	Plans	Units	Acres
	Units1990	Units 2000	Change	2000	Units '00	2000	2001	2001	2001
Birdsboro Borough	1,634	1,927	17.9	1	2	0.40	0	0	0
Brecknock Township	1,332	1,611	20.9	10	0	75.59	3	1	1.6
Caernarvon Twp	766	925	20.8	10	2	44.03	11	23	42.7
New Morgan Borough	14	12	-14.3	1	0	2.50	0	0	0
Robeson Township	2,181	2,568	17.7	12	20	129.32	20	70	375.4
Union Township	1,244	1,370	10.1	3	5	200.00	4	18	73.7

Union Township

The Hay Creek drainage basin within Union Township is located in the southwestern portion of the Township. The total area encompasses 2,753 acres or 18.46% of the land area within the Township.

The majority of the Hay Creek Watershed contained in Union Township is zoned Low Density Residential. The purpose of the Low Density Residential District is to encourage moderate residential development while retaining the rural and suburban characteristics of the Township. A significant portion of the LDR District is classified as having slight to severe limitations to on-lot sewage due to flooding and a high-water table.

The second highest acreage is zoned as the Rural Conservation (RC) District. The purpose of the RC District is to encourage woodland, agricultural, and general open space conservation by preserving natural features and environmentally sensitive land such as forests, watersheds, and water courses while perpetuating the rural atmosphere, open space, and scenic landscape of the Township. A significant portion of the RC District is classified as having severe limitations to on-lot sewage disposal due to flooding, a high water table, and/or steep slopes. Resource and conservation uses are encouraged provided that sufficient space is available for on-lot sewage disposal that will not create any menace to public health, and natural features are not unduly disturbed.

The land surrounding the Village of Geigertown is zoned as Village Commercial (VC) District. The purpose of a VC District is to provide an area for low volume commercial land uses that service the basic needs of surrounding residential communities. The VC District is concentrated around existing commercial land uses that are located along collector and arterial highways within the Township. Development that occurs shall be planned to accomplish safe development of highway frontage and to protect highways and thoroughfares.

The Heavy Industrial (HI) District is located near the southern boundary of Birdsboro where the Diabase formation is present. The purpose of this district is to provide an area for heavy industrial land uses, which services and provides for the basic needs of the surrounding residential communities of the Township. The H I District is located and centralized in an area, which will adequately accommodate industrial growth provided that each existing and proposed land use does not affect the public health, safety, and general welfare of the adjacent residential areas. Birdsboro Materials Quarry is situated in this zone.
The observation has been made that the current zoning does not protect the Hay Creek watershed. The Berks County Planning Commission suggested these communities might consider an appropriate version of the Net Resource Out overlay.

Hay Creek

The Net Resource Overlay concept is to identify resources important to their municipality and to use overlay maps of those resources in the planning process. These resources may be geological, ecological, social, or historic. Such features as steep slopes, wetlands, forests, and sinkholes, might be included. Examples of Net Resource Out Ordinances are available at the Planning Commission.

F. Social / Economic Profile

1. Population

According to census final population counts, population in Berks County increased by 37,113, or 11.03% between the years 1990 and 2000. The total count for 1990 was 336,523, and for 2000 the total was 373,636. The average population change in the municipalities contained within the Hay Creek Watershed varies. The Borough of Birdsboro and Caernarvon Township each saw an increase of approximately 19%; Robeson and Brecknock Townships had approximately 15% increases, while Union Township and the Borough of New Morgan changed by 0.38 and -2.78 respectfully. (Refer to Table 5)

An analysis of population trends was undertaken for the Schuylkill Watershed Conservation Plan. A linear regression was performed on the 1990 population of each municipality to project the population for 2010. Population density, the number of people per unit area, was coordinated with the GIS mapping of watershed boundaries to calculate the number of people in the Hay Creek watershed. Based upon projections, the Hay Creek watershed was in the high threat

category for continued population growth, achieving a projection of 21-30% growth between 1990 and 2010.

TABLE 5. Population Density of Municipalities in the Hay Creek Watershed						
Municipality	**1990 Census**	**2000 Census**	**Percent Change**	**# Change**	**Land Area (Miles^2)**	**Population Density (# per Mi.^{2})**
Birdsboro Borough	4,222	5,064	19.94	842	1.4	3,617.1
Brecknock Township	3,770	4459	18.28	689	17.2	259.2
Caernarvon Township	1,933	2312	19.16	379	8.9	259.8
New Morgan Borough	36	35	-2.78	-1	5.7	6.1
Robeson Township	5954	6869	15.37	915	34.3	200.3
UnionTownship	3440	3453	0.38	13	23.3	148.2

2. Transportation Facilities

a) Highways and Roads

The Hay Creek Watershed is in a fairly remote area of Berks County. As mentioned previously, State Route 82 follows Hay Creek through most of its course. Major traffic routes on the south end of the watershed include State Route 10 and Interstate 176. Both of these roads connect with the Pennsylvania Turnpike in Morgantown and are heavily traveled on a daily basis. Major traffic routes on the north side of the watershed include State Route 724 and US 422 (outside the Hay Creek Watershed on the northeast side of the Schuylkill River.) Route 724 is a major transportation route for travelers between Reading and Norristown. US 422 is a major east-west travel route between central Pennsylvania and Philadelphia. The close proximity of this watershed to these major travel routes makes this area highly vulnerable to development and suburban sprawl from the close-by Philadelphia, Pottstown, and Reading communities.

TABLE 6. Transportation Network.			
Municipality	**State Roads**	**Local Roads**	**Total Mileage**
Birdsboro	2.26	14.40	16.66
Brecknock	18.97	36.36	55.33
Caernarvon	12.25	19.15	31.40
New Morgan	4.13	N/A*	4.13
Robeson	35.13	57.09	92.24
Union	11.67	18.61	30.28

*N/A - not available

3. Major Sources of Employment

The Birdsboro Material Quarry and Browns Feed Mill are two active industries in the Hay Creek watershed. Small farms remain in the southwestern region. Eateries and smaller shops and businesses provide work opportunities in the villages, as do the municipalities, the Daniel Boone School District, and authorities. Forty-four people are employed by the IGA grocery store in Birdsboro. The majority of residents, particularly new arrivals, commute to work as was confirmed by long time residents. According to the year 2000 census, in the above townships, 8724 people spent an average of 26 minutes commuting to work.

TABLE 7. Profile of Selected Economic Characteristics 2000. (Brecknock, Caernarvon, Robeson, Union Townships)

Occupation	#	%
Management, professional and related occupations	2,917	34
Service occupations	707	8
Sales and office occupations	2,062	24
Farming, fishing, and forestry occupations	61	0.7
Construction, extraction, and maintenance occupations	1,224	14
Production, transportation and material moving occupations	1,691	20.0

G. Outstanding and Unique Features

The Hay Creek watershed has an outstanding natural and cultural heritage, which has resulted in a unique rural landscape in Berks County. The combination of abundant water, forests and underlying geology stoked an iron industry starting in 1740 and lasting into the 21st century. Numerous forges and furnaces sprang up on the Hay Creek. The iron masters became influential citizens. Communities, such as Joanna Furnace, were developed as the industry flourished. Remnants of the colonial iron industry remain in places. In many areas the large wooded slopes were denuded in the process of making charcoal. Old collier working roads serve as trails for today's hiker and naturalist. Evidence of early industry is also present along the Hay Creek.

Hay Creek at Stinson Run

1. The Highlands

The Hay Creek Watershed is located in the Highland Region, the eastern most extension of the Appalachian Mountains stretching from Reading, Pennsylvania all the way through northern New Jersey and southern New York to western Connecticut. The Highlands are an essential source of drinking water, clean air, critical wildlife habitat and abundant recreational opportunities for nearly twenty-five million people who live within one hour's travel of the region.

The Highlands Coalition, a group of over ninety organizations, came together to protect these lands and waters. The Coalition has identified sixty-seven "Critical treasures," or priority conservation areas, where additional lands need to be preserved. The Hay Creek Watershed is one of 23 Critical Treasure Areas in Pennsylvania. (The Highlands: Our Backyard Paradise)

Tributary of Indian Run

Stinson Run

2. The Hopewell Big Woods Partnership

When viewing southeast Pennsylvania from space in the 21st century, the observer would notice little in the way of large, unbroken blocks of forest. There is only one notable exception to this observation, the large forest wilderness known as the Hopewell Big Woods, as identified by the Natural Lands Trust (NLT) in 1998. Since then, The Nature Conservancy (TNC) has identified this forest area as its only forest conservation zone in southeastern Pennsylvania through its Lower New England/Northern Piedmont ecoregional plan. The Hopewell Big Woods also ranked #1 in NLT's initial *Smart Conservation* assessment of ten known high quality sites in southeastern Pennsylvania. The Big Woods Partnership was established to provide public and

private stakeholders a forum to exchange information and ideas as the stewardship plan is developed.

Forested lands of the Birdsboro Municipal Authority

The Hopewell Big Woods Partnership seeks to protect at least 15,000 acres of unbroken forest and, in the process, the Exceptional Value streams of the French Creek and Hay Creek watersheds. The partnership also works to protect two rare species found within the boundaries of the Hopewell Big Woods, the Bog turtle (*Clemmys muhlenbergii,* G3S2, State Endangered, Federally Threatened) and Bog bluegrass (G3S2, State Threatened). In recognition of the need to protect the regionally significant Schuylkill River Greenway nearby, the Partnership has also designated the section of the Schuylkill River Greenway adjacent to the forest and watershed areas as part of the Hopewell Big Woods Project Area. In all, the Hopewell Big Woods Project area includes approximately 100 square miles straddling the Berks/Chester County border, with each County containing about half of the total area. (NLT)

NLT notes that the oak forests of the southern half of Pennsylvania originally arose as a result of Native American burning practices, which probably converted a more mixed hardwood forest to mixed oak. Pollen records suggest that this conversion started at least 2,000 years ago. When Europeans arrived in the area of the Hopewell Big Woods, they removed almost all trees on agriculturally suitable soils and used areas of less suitable soils for woodlots, hunting areas, and charcoaling. During the 18th and early 19th centuries, charcoal production in the Hopewell Big Woods increased until virtually all land not in agriculture was being used for charcoal and fuel.

The predominant forest type of the Hopewell Big Woods is Fike's (1999) Dry oak-heath forest. However, red oak-mixed hardwood forest is more common at lower elevations. The only other significant upland forest communities in the Hopewell Big Woods are Red maple (terrestrial) forest and Tulip tree-beech-maple on richer sites. Fire exclusion, lack of soil disturbance, soil eutrophication, and over browsing by White-tailed deer have probably contributed to this trend, with over browsing by White-tailed deer as the likely dominant impact. The richest examples of Dry oak-heath forest occur on ridge top locations on the lands of the Birdsboro Municipal Authority in the lower Hay Creek valley.

French Creek State Park - A Highland Treasure

3. The Hay Creek/French Creek Important Bird Area (IBA)

Pennsylvania Audubon Society manages an Important Bird Area (IBA) program as part of a worldwide effort to identify and protect outstanding habitats for birds and all wildlife. Over 400 IBA areas have been identified in the United States. The Hay Creek-French Creek Piedmont Forest Block IBA has approximately 12,000 acres. This site is a large block of relatively unfragmented, low elevation forest with "interior forest birds" in abundance. The Hay Creek Valley, between White Bear and Birdsboro, due to its complex hydrology, steep topography, rich edge and forest communities, and proximity to the Schuylkill River, has been known to attract a wide variety of migrating and breeding birds since early in this century, especially certain forest dependent Neotropical migrants that are of high conservation concern. This area is identified as a dynamic area for range expansion and contraction for southern and northern species. Hay Creek watershed also received the highest priority rating for habitat protection in the Schuylkill River watershed.

Pileated Woodpecker holes

Field of boulders

4. Trails

At the north end of Hay Creek watershed, the Schuylkill River Greenway Association (SRGA) is converting the abandoned Pennsylvania Railroad into a non-motorized trail. SRGA purchased the right of way from Conrail to advance the establishment of a greenway trail the length of the Schuylkill River. When completed, this 125-mile trail will run through Schuylkill, Berks, Chester, Montgomery, and Philadelphia Counties. A number of sections are currently open. The overall trail is known as the Schuylkill River Trail, while sections are often referred to by a local name. The section in the Hay Creek watershed is known as the Thun Trail. Hikers, bicyclists and equestrians (where width of trail permits) are anticipated to be the main users.

A portion of the 120-mile long Horseshoe Trail is another regional pedestrian artery. The Horseshoe extends from Valley Forge to 12 miles north of Hershey. Both hikers and equestrians use this trail. It snakes through the watershed from Long Hill to Beaver Run.

An unofficial local trail was established when Route 82 was closed after a flood in 1987. Many people walk, run and bike on the roadbed. A dirt lane leads to the Birdsboro Reservoir. Other trails branch off from here, many along former logging roads from the times when the iron industry needed charcoal. Additional dirt roads travel to Stinson Run Reservoir and the Dyers Quarry at Trap Rock.

II. ISSUES, CONCERNS, CONSTRAINTS, and OPPORTUNITIES

Residents of the Hay Creek watershed feel strongly about issues concerning resource protection and quality of life. Concerns and opportunities have led citizens to band together.
The Hay Creek Watershed Association is an organization of community volunteers with the following interests:

- Promotion of an understanding of the relationships between the watershed and present and future land-use options
- Regular stream water quality monitoring to develop a watershed quality database
- Identification of water quality problems
- Support efforts to recognize and improve stream water quality

The Hay Creek Valley Historical Association was organized in 1975 with the following objectives:

- Encourage an appreciation for local history
- Provide a living experience of Berks County's rich agricultural and technological past

The Robeson Township Historical Society also works toward promoting local history and heritage. There are other community organizations, such as the Rotary, Lions and Woman's Clubs, who strive to improve the quality of life for those who live and work in the Hay Creek valley.

Abandoned railroad over Stinson Run

Seep at Indian Run Reservoir

A. Issues/Concerns/Constraints

Throughout the region, the overriding concern is retaining and maintaining the special features of the Hay Creek watershed while dealing with change. Interviews with officials and residents, feedback from public meetings, results from a Hay Creek Watershed Association poll, as well as, relevant issues and concerns outlined in previous studies are summarized below:

1. Loss and fragmentation of forests and wildlife habitat
2. Water quality degradation of Hay Creek and its tributaries
3. Threat of suburban sprawl
4. Loss of farmland
5. Quality and quantity of groundwater
6. Road capacity
7. School shortages
8. Shortage of community services
9. Possibility of increased taxes
10. Ability of local municipalities to deal effectively with growth and change
11. Inadequate communication among adjacent municipalities

1. Loss and fragmentation of forests and wildlife habitat

Throughout the watershed the loss of forests to development, and consequential loss of plant and wildlife habitat is a major concerns. The Hay Creek watershed forests are in the *Hopewell Big Woods*, *a large conservation zone that represents the most important conservation area between Washington D.C. and New England within the Piedmont.* (Barbour 2000, Nature Conservancy) Current zoning does not adequately protect this resource. Human encroachment, invasive plants and animals, deer overgrazing, and natural disasters all take a toll on the forest environment. Past experience illustrates how inappropriate timbering practices often tragically results in environmental and flooding problems. Effort should be spent to encourage permanent protection of forests and to implement appropriate regulations for tree harvests.

French Creek State Park Forest Stewardship Demonstration Area

Protection of Birdsboro Municipal Authority Lands

Birdsboro Municipal Authority (BMA) owns and manages approximately 1,800 acres in the watershed. This forested land surrounds and protects the BMA's water supply. The lands contain many springs and seeps. The Pennsylvania Audubon Society has designated this area as an Important Bird Area (IBA). The land is currently not protected by easement. A proposal to include the BMA lands in the federal Forest Legacy program is being considered by the funding agency. Thirty-seven acres was purchased using funds from "Project 70 Land Acquisition and Borrowing Act", as appropriated June 22, 1964. This indenture is given to provide land for recreation, conservation, and historical purposes as defined in the Project 70 Act. George and Edward Brooke, who also built Indian Run and Stinson Reservoirs for Birdsboro's public water system, originally acquired other BMA lands. BMA's stewardship of these lands and waters have protected the drinking water sources, maintained the exceptional bird and wildlife habitat,

and provided a passive recreational haven for area residents and visitors. Decisions made by BMA regarding their future goals, including growth and maintenance plans, i.e., expansion of service area, will impact regional growth.

2. Water quality degradation of Hay Creek and its tributaries

Glen Morgan Lake

The lake located at the headwaters in the upper Hay Creek, has a long history. Unnamed tributary 63882, formerly part of the Conestoga Creek drainage, was diverted and impounded by Bethlehem Steel as a tailings pond for the Grace Mines. The lake water is dammed and flows from the bottom into UNT 63882, which flows into the Hay Creek. PA Fish and Boat Commission's fishery studies of Hay Creek reported effects from Grace Mine on water quality. The Hay Creek upstream of the confluence with UNT63882 is designated Exceptional Value.

Glen Morgan Lake IBA.

Glen Morgan Lake was designated as an Important Bird Area (IBA) by the Pennsylvania Audubon Society despite its history of Pollution. Located in southern Berks County, Glen Morgan Lake (Carr's Recreation Park) is a private lake covering approximately 150 acres. This area is a highly productive wetland habitat in the Piedmont region of Pennsylvania. The Lake is relatively shallow with thick emergent vegetation and open water rich in submerged aquatic plants and invertebrates. Ruddy Ducks have been recorded breeding at this site and the lake supports the largest known breeding colony of Pied-billed Grebes in Pennsylvania (National Audubon Society, 1999). The complex history of the lake and the current IBA status elevate this water body to a priority concern on multiple levels. At a minimum the discharge from Glen Morgan Lake should be monitored continuously.

Maintain Water Quality with Goal to Upgrade

Beaver Run flows through forested land into an agricultural valley. Attempts should be made to maintain the high water quality standard of the cold waters fishery. This can be achieved by implementation of best management practices for erosion control, sedimentation reduction, riparian buffer establishment, and cattle exclusion fencing. Implementation of the above

mentioned measures would be a valuable step in the process to upgrade the stream to exceptional value. Additionally, maintenance and improvement of the fish habitat would encourage continuation of the native brook and brown trout populations.

Water Quality of Hay Creek and Tributaries

Exceptional Value status regulations are written to afford greater stream protection measures than other stream designations; therefore the EV status of Hay Creek should be maintained. All tributaries of an EV stream are also considered EV, and afforded the same protection. The pristine waters of Indian Run and Stinson Run are of great importance because they are the source of drinking water for Birdsboro and also feed into the EV stream section of Hay Creek. The reservoir at Dyers Quarry at Trap Rock and the main stem of the Hay Creek (intake opposite the Stinson confluence) are the other sources of potable water deserving protection. The good waters of this stream section are highly attractive to fisherman.

The section of Hay Creek from the Birdsboro Borough line to the confluence with the Schuylkill River is designated a cold waters fishery. This section also receives the discharge from the Birdsboro WWTP whose outfall is near the Schuylkill River. Previous problems with high copper levels in the effluent have improved according to State Officials. Efforts should be made to improve and upgrade water quality in this section of Hay Creek.

➢*Haines and Kibblehouse's Birdsboro Materials Quarry*

Chestnut Hill is underlain with diabase rock. H&K is mining for diabase, sandstone conglomerate, shale, topsoil and overburden. In March 1999 the PA DEP approved a permit that requires H&K to mine the site in two phases. Phase one includes 121 acres. The overall proposed permitted area consists of 289.6 acres. One state official noted that the topographical map of the site after all quarry work would be completed had very few lines indicating that the quarry operation will result in the removal of Chestnut Hill.

Birdsboro Materials Quarry, Indian Run Reservoir on right.

Several of the springs of the Indian Run watershed are located on H&K's property. Concerns have been raised as to how this industrial operation may impact site wetlands and the unnamed tributary, as well as its relationship to the Indian Run watershed and Birdsboro's drinking water source. Others have voiced fears that blasting could negatively disturb the habitat of geotropic migrant bird species. Nearby homeowners on Hopewell Street, Birdsboro have voiced complaints to Robeson Township. The July 17, 2003 *Reading Eagle* reported "*One resident complained to the township three times in 12 days and said the blasting has shook her entire house on Hopewell Street in Birdsboro. Another Birdsboro resident complained July 11 that the blasting cracked the foundation of his home and shook the deck.*

3. Threat of suburban sprawl

➢ *Mixed Use Development*, New Morgan Borough
A large housing development is currently in the planning stages for the Borough. Projects of this size are cause for concern due to the potential increased risk of flooding and /or erosion caused by vegetation removal, reduced ground water infiltration, and increased stormwater runoff.

➢ *Zoning in Borough of New Morgan*
Borough Zoning ordinances are sufficiently vague as to allow uncontrolled and unstructured development.

➢ *Sewage Treatment Plant, Geigertown*
Numerous septic system failures in the Geigertown area have generated interest in a larger wastewater treatment plant (WWTP) to handle the additional influent from new hookups. The need to correct the septic system problem to reduce surface and ground water pollution is understandable and desirable. The increased potential for residential development resulting from an upgraded WWTP is of concern.

Municipal Zoning
Zoning ordinances should be written or strengthened to protect forestlands and sensitive resources. The Berks County Planning Commission has experience assisting municipalities with the development of such ordinances. Available information includes examples of successful zoning, overlays, and other strategies municipalities can adopt. A number of municipalities have adopted Net Resource Out overlays to protect physical and natural resources important to them.

Route 82
During 1987 a flood occurred that washed out 8,379 lineal feet and four bridges of State Highway Route 82 in Robeson Township. This resulted in road closure from the Rustic Picnic Area, Birdsboro, to beyond the gravel road leading to the Birdsboro Reservoir. The Birdsboro Municipal Authority (BMA) and Haines and Kibblehouse (H&K) own the affected land. H&K trucks have road and train access, and BMA has access on the closed road. The public has been redirected to PA Route 345 as a detour. Penn DOT is proposing to reopen the road via an alternative route over quarry land. In addition to lands of BMA and H&K, this route reconfiguration requires utilizing strips of properties of two individual landowners. The proposed route will require fewer bridges and be further away from Hay Creek in most areas. However, in one section, Penn DOT proposes to construct a retaining wall along Hay Creek (EV section) where the road runs adjacent to the creek. Penn DOT further proposes to incorporate a bicycle trail and connect into a proposed future rail trail. Public opinion is divided on this topic. Environmental concerns include disruption of habitat and conditions for conservation of forest interior bird species. Additional concerns include loss of forest edge, road noise, storm water discharge into an EV stream, and increased accessibility promoting sprawl development.

Birdsboro Heights Subdivision and Development
Haines and Kibblehouse, Inc. (H&K) has proposed to construct a large (270 units) single family housing development on property it owns in Union Township. This parcel was part of the

Chestnut Hill property H&K had purchased for stone extraction. Union Township granted preliminary approval to a scaled down version of the current proposal. The underlying geology, diabase, is known for its low yields of water. Therefore state officials say the developer will need to secure public water and sewer for a project of this magnitude.

H&K formed the Birdsboro Heights Water Company and sunk 3 wells. One of these is contaminated, and the remaining two do not provide the volume of water needed. H&K has been investigating remediation actions, stripping and diluting the polluted source, as well as obtaining public water from BMA.

An unnamed tributary on the H&K property enters the Hay Creek where it has received Exceptional Value designation. According to the law, this tributary should be afforded the same EV protection. A state official said this situation means H&K will not be able to build a separate sewage plant for its development because they could not discharge into this tributary. The most logical alternative would be to extend Birdsboro's sewer to include this new area. Because Birdsboro's plant is currently at capacity, the Borough will either need to address an infiltration problem, or to expand its plant before it can accommodate H&K or any other new clients. The land is currently forested, and located between Birdsboro and the Indian Run Reservoir on Long Hill.

4. Loss of farmland

➢ *Loss of Farmland*

Most of the region's farms are privately owned and do not have agricultural easements or other protective provisions. Loss of agricultural lands to development is a threat to the overall health of the watershed.

5. Quality and Quantity of Groundwater

Conestoga Landfill

This landfill is located in the Borough of New Morgan in the Conestoga Watershed. This photograph of the landfill and Glen Morgan Lake taken from the Fire Tower on Williams Hill illustrates the potential of drainage into the Hay Creek Watershed. The landfill is located near old mining operations and is currently applying to expand their operating permit. Continuous monitoring of the landfill liner integrity, cover, surface runoff, and groundwater discharge are critical to the health of the Hay Creek Headwaters.

Protection of Wetlands, Springs and Seeps

It is important to the continued health of the Hay Creek to protect its headwaters, wetlands, springs and seeps. These sensitive areas should be identified and municipalities should consider measures that respect these resources. Particular attention should be taken to protect the seeps and wetlands near the Bridgeview Infectious Waste Incinerator.

Indian Run Reservoir

Stinson Run Reservoir foreground

Indian Run Reservoir background

B. Opportunities

Rail-Trail

The abandoned Wilmington and Northern Railroad bed has the potential to be converted into a rail-trail. The former rail line travels through Scarlet's Mill to Cold Run and Joanna Heights before heading into Elverson in Chester County. The potential rail-trail could also connect the Birdsboro Municipal Authority's trail system in the lower Hay Creek. Additional connections with the Schuylkill River Trail and Glen Morgan Lake are possible. Additionally, the Pennsylvania Department of Transportation proposed to tie the bike path along re-routed PA 82 into the abandoned Wilmington and Northern Railroad. This future regional rail-trail would connect the Schuylkill River Trail, Horseshoe Trail and Struble Trail in Chester County. Berks County has undertaken this project, although there are many challenges to overcome, including resolution of land ownership and title, before serving the public as a trail.

Scarlet's Mill historic area

Beaver Run flows into Hay Creek at Scarlet's Mill. The section of Hay Creek below the confluence of Beaver Run is designated Exceptional Value. The National Park Service is currently studying this region because of its proximity and historic relationship with Hopewell Furnace National Historic Site. A description of the historical significance of Scarlet's Mill can be found in the book titled "*Sketches of Scarlet's Mill, Robeson Township, Berks County, Pennsylvania*" by Jere E. Brady.

Scarlet's Mill, also known as White Bear

Schuylkill Canal

The Schuylkill Canal was built in 1824. It was a slack water system, with dam pools that allowed greater use of the Schuylkill River, and a series of locks in the parallel reaches of canal. The Girard Reach was in the Birdsboro area, with the 5-arch brownstone Hay Creek Aqueduct crossing the Hay Creek. Berks County Parks and Recreation Department oversees the C. Howard Hiester Canal Museum at the Berks County Heritage Center along the Tulpehocken Creek. It is an excellent place to learn about the canal industry.

William Bird House

William Bird was one of the earliest settlers in the region. He purchased thousands of acres, took advantage of the waterpower of the Hay Creek, and engaged in the colonial iron industry. He built the first forge, and at the time of his death circa 1760, he owned three thousand acres of land, three forges, a gristmill and a sawmill. Built in 1751, the fine two story, cut-sandstone mansion-house faced the Schuylkill River, with a lawn stretching to its banks. On the side along the Hay Creek stood a grove of old trees which Mark Bird, William's eldest son, had fenced up and used as a deer-park. This building was the residence of all the early proprietors of the iron works, until the Schuylkill Canal was built in front of the house, and it was no longer suitable as a residence.

According to historian Bruce Hoffman, this area of the Schuylkill was known as Birds Landing. The Bird House is used as a community center. It is the recommendation of this Plan that sites and structures related to the iron making history and heritage of the Hay Creek watershed be preserved.

A number of opportunities are addressed in the preceding section, Issues/Concerns/ Constraints. Additional recommendations for positive action in the watershed are detailed in the Management Options section.

- Landowners can explore new opportunities, such as the federal Forest Legacy Program. BCC is the local sponsor for the program in the County and is responsible for grant submissions. Landowners interested in this program should contact BCC for information and assistance.
- French Creek State Park established a Forest Stewardship Demonstration Project. Various timber-harvesting techniques were demonstrated in test plots. Periodic observation of the plots illustrates forest recovery from different harvesting methods. A harvest technique may then be selected depending on the desired recovery sequence. (See appendices.)

- NLT is designing a Landscape Conservation Plan for the Hopewell Big Woods. Landowners with forests may avail themselves of these designs by contacting NLT.
- Organizations such as the BCC can offer additional advice regarding conservation easements.

Working Together and Communication

Communication among citizens, private groups, businesses, and municipalities on topics of common concern is critical to achieving consensus and collective goals.

Education and Community Projects

Local organizations have successfully staged events and festivities to involve the community in environmental issues. Activities for children, such as collecting macro invertebrates, are both fun and educational. Continuation of these activities will foster well-rounded and environmentally concerned citizens.

Hay Creek Watershed Association and Berks County Conservancy officials demonstrate drainage patterns on watershed model. Hay 5K at Rustic Picnic Area, Spring 2003.

The Hay Creek watershed in its entirety falls within the region federally designated as the Schuylkill River Watershed National Heritage area. The Schuylkill River Greenway Association (SRGA) administers this program. Grants are available for studies and projects that advance the development of this regional heritage park. The proposed rail trail, projects that interpret the colonial iron industry, and heritage tourism are a few examples of types of projects that could be jointly pursued with SRGA.

Seminars and illustrated talks about the special cultural and natural resources of the Hay Creek watershed is another way of sharing the region's heritage with the public.

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III. LAND RESOURCES

A. Soil Characteristics – Group, Type, Classification, Geology

The soil physical properties are the determining factor in the sediment-transport characteristics of Hay Creek and its tributaries. The soils, in turn, are determined by geology and weathering processes of the parent rock. The underlying geology of the Piedmont physiographic region furnishes the basis for the Hay Creek watershed's soil associations and soil characteristics.

Local geology provides parent material for soil

The dominant soil series found in the watershed are: Joanna, Abbottstown, and Readington Series. These three series represent 95% of the watershed and will therefore be explained in more detail than the various smaller soil series. Soil Characteristics of all soil series in the watershed can be found in Table 8.

Joanna series is the most dominant soil series found in the Hay Creek watershed. These soils represent 88% of the watershed and are located in areas of Triassic red sandstone and conglomerate hills and ridge. Joanna series is very deep, well drained, with moderate permeability and a slope range of 0 – 60%. Joanna's associated soils are Readington and Abbottstown series.

Abbottstown series represents 4% of the watershed and is located in red shale valleys. These soils are deep, somewhat poorly drained, with moderate permeability and a slope range of 0 – 8%. Abbottstown soils are formed in residuum from acid red shale, siltstone, and sandstone.

Readington series make up 3% of the Hay Creek watershed and are found in red shale, siltstone, and sandstone hills between valleys. These soils are formed in colluvium weathered from red shale, siltstone, and fine-grained sandstone residuum. The Readington series consists of deep, moderately well drained soils, with moderate permeability and a slope range of 0 – 8%.

1. Agricultural Capability/Limitations

Land capability classification illustrates the suitability of soils for most kinds of field crops. Classes range from one to eight. Soils in Capability Class I are the best for farming because they have the fewest limitations, the widest range for use and suffer the least damage when used. Soils in Class VIII have the most limitations, produce lower yields, and are most subject to degradation.

Table 8: Characteristics of Soil Types in the Hay Creek Watershed					
Soil Type (Series)	**Slopes (%)**	**Depth Class**	**Drainage**	**Permeability**	**Landform**
Abbottstown	0 to 8	Deep, moderately deep	Poorly drained	Moderate	Red shale valleys
Birdsboro	0 to 8	Very deep	Well drained	Moderate	High stream terraces between shale hills and old alluvial fans
Bowmansville	0 to 3	Very deep	Poorly drained	Moderate	Slightly dissected flood plains
Brecknock	0 to 25	Deep	Well drained	Moderate	Gray shale hills
Croton	0 to 8	Very deep	Poorly drained	Moderately slow	Colluvial valleys between shale and sandstone hills
Gibraltar	0 to 3	Very deep	Well drained	Moderately rapid	Floodplains in valleys between shale and sandstone hills
Joanna	0 to 60	Very deep	Well drained	Moderate	Triassic red sandstone and conglomerate hills and ridges
Klinesville	3 to 50	Shallow	Excessively drained	Moderately rapid	Red sandstone hills between mountains
Lamington	0 to 3	Very deep	Poorly drained	Moderate	Alluvial valleys and streams terraces
Neshaminy	0 to 60	Deep	Well drained	Moderate	Diabase hills between mountains
Penn	0 to 25	Moderately deep	Well drained	Moderate to moderately rapid	Red Triassic shale and siltstone hills
Raritan	3 to 8	Very deep, moderately deep	Moderately well drained	Moderate	Red shale and sandstone valleys between hills
Readington	0 to 8	Deep	Moderately well drained	Moderate	Red shale, siltstone, and sandstone hill between valleys
Rowland	0 to 3	Very deep	Moderately well drained	Moderately slow	Flats of alluvial valleys between red shale, siltstone and sandstone hills
Udorthents	0 to 60	Very deep	Moderately well drained to well drained	Very slow to very rapid	Hills, ridges, valleys, mountain floors, mountain flats, mountain valleys, mountains

Soil on Stinson Run

Soil by Furnace Road

Steep rocky wetlands

The U.S.D.A Natural Resource Conservation Service uses Soil Capability Class information when preparing Farm Conservation Plans for individual farmers. These plans map soil characteristics to determine land use, as well as, appropriate farming and conservation practices.

Prime Farmland soils, classified, as Soil Classes I and II, are level to gently rolling, well drained, with generally high available moisture capacity and high natural fertility. These soils are capable of producing high yields with less input of fertilizer, erosion control, irrigation, and labor expenditures for the farmer.

Class I soils are not present in the Hay Creek Watershed. The Prime Agricultural Lands are Soil Capability Class II, and located in the valley floor along the Hay Creek and Beaver Run. As would be expected, these areas also correspond with the Hay Creek Land Cover Map.

2. Suitability for Community Development

Soil survey maps and soil characteristics can help in planning community development and engineering projects. The U.S.D.A. Soil Survey includes tables that show the kind and degree of limitations that affect the use of land for various purposes. Soil features that are related to community development requirements are: depth to bedrock, degree of slope, permeability, incidence of flooding, depth to a seasonal high water table, texture of soils, and stoniness. Ratings of *slight, moderate,* and *severe* have been used to describe the degrees of limitation. A rating of *slight* indicates that the degree of limitation can be none to slight, but few soils have no limitations.

3. Forest Productivity/Limitations

Forest productivity ratings can help forest owners or managers plan the use of soil for wood crops. The rates indicate the potential productivity of the soils for wood crops and limitations that affect various aspects of forest management. Joanna soils rating indicate a moderate hazard of off-road or off-trail erosion and severe erodibility on roads and trails. Abbottstown soils pose a slight hazard for both on and off-road or trail erosion. Readington soils show a slight hazard of off-road or trail erosion and moderate erodibility on roads and trails.

View from Geigertown Road

Agricultural land near Geigertown

4. Construction Materials Classification

Construction material classification gives information about the soils as potential sources of gravel, sand, topsoil, reclamation material, and road fill. The soils are rated good, fair, or poor as potential sources for the construction materials based on the: amount of suitable material, soil properties that affect the ease of excavation, and performance of the material after it is in its place. The ratings are for the soil from the surface to a depth of about 5 feet. It is assumed that the soil layers will mix when soil material is excavated and spread.

Joanna soils are a poor potential source of gravel and sand, fair potential source of topsoil, and a good source of road fill. Abbottstown soils rate as a poor potential source of all construction materials. Readington soils rate as a poor source of gravel, sand and road fill, but a fair potential source of topsoil.

4. Soil Limitations

Ratings of not limited, slightly limited, somewhat limited, and very limited show the degree and kind of soil limitations for the specified use. Not limited indicates that the soil has features favorable for the specified use and therefore, good performances and low maintenance can be expected. Slightly limited indicates the soils limitations are minor and can be easily overcome. Somewhat limited indicates the limitations can be overcome or minimized by special planning, design, or installation. Very limited rating shows the soils have one or more features that are unfavorable for the specified use and poor performance and high maintenance can be expected.

5. Building Site Development

Soil properties are important factors in the development of building sites. Soils influence site selection, structure design, construction, performance after- construction, and maintenance. Soils are rated on their limitations that affect dwellings with and without basements, small commercial buildings, local roads and streets, shallow excavations, lawn and landscaping. Joanna and Abbottstown series are rated as very limited for all building site development activities. Readington soils' rating is very limited to dwelling with basements and shallow excavations, and somewhat limited to dwellings without basements, small commercial buildings, local roads, lawn and landscaping.

6. Sanitary Facilities

Soils are rated by their limitations that affect sanitary facilities. Joanna soils are rated as somewhat limited for trench sanitary landfill, area sanitary landfill, and daily cover for landfill,

and are unsuitable for septic tank absorption and field lagoons. Abbottstown and Readington soils are both unsuitable for sanitary facility uses and are given a rating of very limited.

7. Water Management

Soils are rated by their limitations that affect water management activities. Joanna soils are rated very limited for aquifer-fed excavated ponds, embankments, dikes and levees, and somewhat limited to pond reservoir areas. Abbottstown soils are somewhat limited to aquifer-fed excavated ponds and reservoir areas, and unsuitable for use in embankments, dikes and levees. Readington soils are somewhat limited to all water management uses.

8. Recreation

Soils are rated according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Joanna soils are rated as very limited for recreational uses. Abbottstown soils are somewhat limited to paths and trails, and off-road motorcycle trails, but are rated as very limited to all other listed recreational uses. Readington soils are more suited to recreational trail activities and are given the rating of not limited to paths, trails, and off-road motorcycle trails, and somewhat limited for golf fairways, playgrounds, camping and picnic areas.

10. Geology and Landform

The geology and landform of the Hay Creek watershed falls entirely within the Gettysburg-Newark Lowland section of the Piedmont physiographic province. Hay Creek Basin is divided into trap rock conglomerate uplands and Triassic lowlands. Landforms of the Gettysburg-Newark Lowland Section consist mainly of rolling low hills and valleys developed on red sedimentary rock. There are also isolated higher hills developed on diabase, baked sedimentary rock (hornfels), and conglomerates. Almost all of the underlying sedimentary rock dips to the north or northwest and many of the smaller drainage ways are oriented normal to the direction of the dip so that some of the topography has a northeast-southwest linearity. However the basic drainage pattern is dendritic.

Boulder with dog

Conglomerate sandstone

The Brunswick Formation

The Brunswick formation is located in the northeast region of the lower Hay Creek in and around Birdsboro and the Schuylkill River. The Brunswick Formation is typically soft, grayish-red to reddish-brown, evenly to irregularly bedded, thin-to thick-bedded shale, mudstone, or siltstone locally interbedded with fine-to coarse-grained red sandstone. Mud cracks, ripple marks, crossbeds, burrows, and raindrop impressions are common.

The Brunswick Formation is moderately resistant to weathering, forming broad shallow valleys with hills of low relief that trend parallel to the strike of the beds. Joints have a blocky pattern, are moderately abundant, and are commonly open; infillings include calcite and quartz; occasional barite and pyrite are present. The regolith is moderately thick.

Terrain of Brunswick Formation, Birdsboro

Diabase

A northeast-southwest oriented narrow band of diabase, one-eighth to half mile wide, is adjacent to the southern boundary of the Brunswick formation in the lower Hay Creek. The former Benjamin Pupeck Quarry and Dyers Quarry at Trap Rock were located in this region. The current Birdsboro Materials Quarry mines diabase, sandstone conglomerate, shale, topsoil, and overburden from this formation. The igneous nature of diabase explains its physical characteristics as dense, crystalline, erosion-resistant outcrops that weather to form large boulders. Diabase, also known as “black granite” or “trap rock”, has been used for headstones and support stones for large engineering projects, but was generally considered too dark to be used as building stone. Diabase occurs as dikes and sills throughout the Gettysburg-Newark Lowland, underlying about 260 square miles. Dikes are generally between 5 and 100 ft thick, and major sills are commonly 800 to 2,500 ft thick. The reference section is at Devils Den in Gettysburg National Park, Adams County.

Diabase is dark gray to black, medium- to coarse-grained in the center of large intrusions and fine-grained at contacts and in narrow dikes. The lithology of Diabase is remarkably uniform. The major minerals labradorite and augite are present in about equal proportions; ilmenite,

quartz, and apatite are accessory minerals. Diabase is highly resistant to weathering and commonly weathers to large spheroidal boulders. Dikes typically form narrow ridges, and larger intrusions form hills of moderate relief. Joints are well developed, abundant, and open. A thin mantle composed of relatively impervious stiff clay generally overlies the Diabase. Low-lying areas underlain by Diabase are poorly drained. In some areas, the Diabase has intruded into bedding planes as sills and also may have followed fractures created by faults. The shales and sandstones in the immediate vicinity of the Diabase have been thermally altered to porcelanite and their color changed from red or brown to blue-black by reduction of the iron oxide.

Thermally altered Sandstone

Diabase Boulder

Diabase cliff

New Oxford Conglomerate

Distinct alternating bands of New Oxford Conglomerate and Hammer Creek Formation adjoin the Diabase at a perpendicular angle. Orientation is southwest to northeast. The southwestern section of the lower Hay Creek, the entire Beaver Run area and the upper Hay Creek with the exception of the southeastern rim have this pattern of surface geology. The communities of Scarlet's Mill, Geigertown, and Joanna Furnace are in this region. The New Oxford Conglomerate is characterized by quartz or quartzite pebbles, cobbles, and rare boulders set in a red, sandy, ferruginous matrix, some silica cement, and some feldspar clasts. Clasts are the gravel, sand and silt textural components of most clastic sedimentary rocks. The Matrix is the fine-grained material surrounding clasts. The Cement is the textual component of silica, calcite, or iron oxide – the "glue that holds the rock together.

Hammer Creek Formation

The Hammer Creek Formation underlies about 130 square miles of the Gettysburg-Newark Lowland in Berks, Chester, Lancaster, and Lebanon Counties. The western most extent of the formation has been arbitrarily drawn at the Dauphin-Lebanon County line and the eastern most extent near the Schuylkill River. The type section is along Hammer Creek, Lebanon County. The Hammer Creek Formation consists of red, brown, and less abundant light gray to gray, very fine to coarse-grained and conglomeratic, thin-to thick-bedded sandstone and thin-to medium-bedded red shale and siltstone. The sandstone exhibits some crossbedding, lensing, channeling, and ripple marks; the shale and siltstone show ripple marks and mud cracks. The Hammer Creek sandstones grade into siltstones and conglomerates. The conglomerate member is thick bedded with clasts or interbeds of quartz, quartzite, sandstone, limestone, and shale. The easily eroded red shale is the dominant rock type in the extreme eastern and western parts of the outcrop belt. Maximum thickness estimates of the Hammer Creek Formation range from about 9,200 to 12,200 ft.

The Hammer Creek Formation is moderately resistant to weathering, generally forming a rough terrain of high relief. Joints have a blocky pattern, are moderately developed, moderately abundant, and open. Thickness of the regolith is variable and commonly thinner over the conglomerate member. The Hammer Creek Formation is of Upper Triassic age and is the coarser-grained, partial lateral equivalent of the Gettysburg Formation to the west and the Brunswick Formation to the east.

Boulders along Furnace Road

Stockton Formation

The Stockton Formation is located at the southeastern corner of the Hay Creek watershed, stretching approximately from Joanna Heights to the Union/Robeson boundary at French Creek State Park. It is oriented southwest to northeast, and is entirely in the upper Hay Creek. The Stockton Formation underlies about 240 square miles of the Gettysburg-Newark Lowland Section in Berks, Bucks, Chester, and Montgomery Counties. The reference section is north of Valley Forge along the Schuylkill River and along a railroad cut west of the Schuylkill River in Montgomery County; the type locality is near Stockton, N.J.

The Stockton Formation is light-to medium-gray, orange, brown, red, thin-to thick-bedded, fine- to very coarse grained arkosic sandstone, arkosic conglomerate, shale, and siltstone. Individual beds in this formation typically grade from coarse-to fine-grained over rather short lateral distances; however, lithologic units may be as thick as 120 ft. These rocks contain channels; ripple marks, mud cracks, crossbeds, pinch-and-swell structures, and minor burrows. Pinch outs, interbedding, crossbedding, and lensing are also common. The sandstone, shale, and siltstone of the Stockton Formation are slightly resistant to weathering while the conglomerate is moderately resistant. These rocks form undulating valleys of low relief. The regolith is generally thin and ridges and valleys commonly parallel the strike of the beds. The Stockton Formation is of Upper Triassic age and is the lowermost formation of the Newark Supergroup in the Newark Basin.

Hammer Creek Conglomerate

The sixth type of surface geology is the Hammer Creek Conglomerate. This small band, oriented southwest to northeast, is entirely in New Morgan, in the upper Hay Creek. Hammer

Creek Conglomerate is of the Triassic Age. The dominant lithology, volumetrically, is Quartz conglomerate. The second most dominant lithology is Sandstone.

B. Land Ownership

1. Public Lands

There are several large tracts of public land in the watershed. The Birdsboro Municipal Authority (BMA) owns 1,800 acres in the lower section of the stream. This land is in both Union and Robeson Townships, and includes and surrounds BMA's water supply intakes. The water supply areas are Indian Run Reservoir, Stinson Run Reservoir, Dyers Quarry at Trap Rock, and Hay Creek (intake located near the pumping station). All water is pumped into the Indian Run Reservoir. As described earlier, with the exception of the reservoirs, seeps, wetlands and streams, all land is forested. BMA maintains numerous dirt roads throughout the property which double as popular hiking and birding trails.

Another large track of public land is French Creek State Park that spreads across 3 watersheds - French Creek, Hay Creek and Sixpenny Creek. Six hundred ten acres of the 7,475-acre park are in the Hay Creek watershed. The 3.6-mile Turtle Trail circles through this area. Additional Municipal parks include the 5-acre Rustic Picnic Area along Hay Creek, the 6 acre Optimist Field, and 6.9 acres of community ball fields and parks in Birdsboro. Seven acres of playing fields are in Robeson Township. Public or quasi-public lands cover 2,745 acres or approximately 19% of the watershed.

2. Private Lands

Large privately owned areas include the 500 acre Carr's Recreation Park at New Morgan (including Glen Morgan Lake), 112 acre High Point Chapel Church Camp, the 14 acre Joanna Furnace Historic Village and the 19 acre Green Hills Sportsmen's Club. The remaining land is under individual private ownership. The total area for the watershed is 14,151 acres with 81 % in private hands.

C. Critical Areas

The following list represents critical areas discussed in various sections of this plan.

- Route 82
- Glen Morgan Lake
- All headwaters
- Floodplains
- Hopewell Big Woods
- Birdsboro Water Authority Land
- All wetlands

Cow pasture

Farm near Geigertown

White Bear Road

D. Landfills

There are two major landfills to the north and south of the watershed: Pioneer Crossing, across the Schuylkill River from Birdsboro, in Exeter Township, and the Conestoga Landfill, in New Morgan. Both are municipal waste landfills operated under DEP regulations in accordance with environmental protection standards. The Pioneer Crossing Landfill is in the Schuylkill River Watershed but on the opposite side of the river from the Hay Creek.

The Conestoga Landfill drains into the Susquehanna River Watershed via the Conestoga Creek drainage area. This drainage system is adjacent to Hay Creek. The underlying fractured porous limestone is connected to the former Grace Mine shafts and is a potential link between the two watersheds. This landfill is the largest of five in Berks County covering 426 acres and receiving 7,210 tons of trash per day. Approximately 70 percent of this trash is from out of state. Major concerns regarding this site involve odor issues, truck traffic and safety, and potential surface and ground water contamination. Violations for odor problems continue although the landfill incurred less total violations than the other four smaller Berks County Landfills.

E. Hazard Areas

1. Quarries and Mining

Historically, Hay Creek watershed's geological resources have been mined and quarried. The *Township and Map of Berks County, Pennsylvania, 1862* depict the Levi B. Smith and Company, E. and G. Brooke, Hampton Furnace, and Joanna Furnace. The *Illustrated Historical Atlas of Berks County Pennsylvania, 1876* additionally lists Peter Brusstar and Company sandstone quarry, Peter Brusstar and company stone quarry, and a brickyard. Locally mined iron ore provided resources for the Smith, Brooke, and furnace operations, as well as, colonial iron ventures beginning along the Hay Creek in 1740.

A later quarry, opened by Dyer and Company in 1893, was on property formerly of the E. and G. Brooke Iron Company. It was a large operation, at one time operating four crusher plants to produce 2,000-2,500 tons of crushed material daily. The rock was shipped to all parts of the country. One hundred twenty to one hundred fifty people were employed. Quarry operations

ceased, and the pit filled with water. This reservoir is one of four sources of drinking water for Birdsboro. Rock climbers scale the walls of the former quarry.

Birdsboro Materials Inc. Quarry

Haines and Kibblehouse, Inc. reopened and expanded upon the former Benjamin Pupek quarry in Robeson and Union Townships. Known as Birdsboro Materials Inc., the quarry is being mined for diabase, sandstone conglomerate, shale, topsoil, and overburden. In March 1999 the PADEP approved a permit that requires Haines and Kibblehouse to mine the site in two phases. Phase one includes 121 acres. The overall proposed permit area consists of 289.6 acres.

2. Sinkholes

Sinkholes occur in limestone and dolomite geology, and are therefore not a problem in the Hay Creek watershed.

3. Earthquakes

Earthquakes in southeastern Pennsylvania, including those in Lehigh, Berks, Lebanon and Lancaster Counties, correlate with the northern and southern margins of the Triassic rift basin (Newark-Gettysburg Basin). The last recorded earthquake in the area occurred on May 28, 1906 in Geigertown.
(http://muweb.millersville.edu/~esci/geo/quake.html)

IV. WATER RESOURCES

A. The Major Tributaries
Protecting Water Resources

Achieving and maintaining high quality water resources is a goal and a challenge for state, county and local governments and for landowners and residents throughout the commonwealth. Pennsylvania has over 83,000 miles of streams, more stream miles than any other state except Alaska. Over the years, development and agriculture have removed natural forest canopies that once covered and protected thousands of stream miles. During the 18th and 19th centuries, vast forested areas of the Hay Creek watershed were denuded by the iron industry. These forests have since regenerated. In the past decades, sprawling residential growth has accelerated in Southeast Pennsylvania, including the Hay Creek region. The projected population growth in the watershed will undoubtedly impact area water resources.

There is a very strong economic incentive to address water quality issues on a watershed basis. It makes economic sense to prevent degradation rather than remediate pollution, to plan protection strategies rather than to react to problems, and to work across municipal boundaries to protect irreplaceable water resources. The health of our ecosystem, and our own quality of life, will be the beneficiaries.

To assist with this challenge, Pennsylvania has implemented statewide watershed activities including the proper classification and protection of Pennsylvania's waters. State water quality standards, mandated by the Clean Water Act, are regulated and set by the Pennsylvania Department of Environmental Protection with approval from the Environmental Protection Agency. These standards are specified in Chapter 93 of the Pennsylvania Code. As part of Chapter 93, stream reaches for protected uses are designated based upon specific water quality and biological conditions. Designations and protected uses for the stream reaches within Hay Creek watershed are defined as follows:

TSF: Trout Stocking Fishery – Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna that are indigenous to a warm water habitat.

CWF: Cold Water Fishery – Maintenance and/or propagation of fish species, including the family Salmonidae, and additional flora and fauna, which are indigenous to a cold-water habitat.

HQ: High Quality Waters – A stream or watershed that has excellent quality waters and environmental or other features that require special water quality protection.

EV: Exceptional Value Waters – A stream or watershed that constitutes an outstanding national, State, regional, or local resource, such as waters of national, State, or county parks or forests, or waters which are used as a source of unfiltered potable water supply, or waters of wildlife refuge or State game lands, or waters which have been characterized by the Fish Commission as

"Wilderness Trout Streams," and other waters of substantial recreational or ecological significance.

The classifications **HQ** and **EV** are special protection waters, required by State law to be maintained at their existing quality. Local government ordinances should incorporate good design techniques and buffer zones for the continued protection of the areas in these designated watersheds. Limiting erosion and sedimentation on construction sites and maintaining as much natural vegetation on the site as possible are two basic environmentally sound practices that can be enforced. Maintaining buffers along stream and creek banks and reducing the amount of impervious surfaces are additional items that can be incorporated into local ordinance regulations.

1. Exceptional Value Tributaries

Hay Creek watershed has excellent headwater streams with sections designated as Exceptional Value. These streams provide invaluable habitat for aquatic biota and form the most direct connections with their surrounding ecosystems. Smaller streams tend to be most impacted by human activities and the most susceptible to local degradation.

The headwaters EV designated area begins at the southwestern quadrant of the upper watershed, in Brecknock and Robeson Townships, flows through the Borough of New Morgan to where the Glen Morgan Lake tributary (UNT63882) enters the Hay Creek.

EV tributary along Furnace Road

The PA Fish and Boat Commission, Bureau of Fisheries Management Division studied the Hay Creek in July 1991. A report was prepared by R. Wnuk and M. Kaufmann and written in March 1993. The following excerpts are from two stations located in the EV headwaters.

<u>Station 0101 (River Mile 10.72)</u>

Station 0101 was located in an ungrazed pasture, but the stream channel at the upstream end of the station was heavily shaded by impenetrable brush. Bank erosion was moderate and the bottom substrate consisted of silt, sand, and rubble. The station was primarily composed of short, shallow pools and short riffles. Overhanging grasses provided the only fish cover.

Physical-chemical parameters and their associated values measured at Station 0101 on July 24, 1991, were as follows: air temperature 26.0°C, water temperature 22.0°C, specific conductance 80 umhos, pH 7.0, total alkalinity 15 mg/l, and total hardness 29 mg/l. Values of Physical-chemical parameters at Station 0101 in 1991 were generally comparable to those measured at the station by Boyer in 1987 when seasonally adjusted.

The aquatic macroinvertebrate community was not sampled at Station 0101 in 1991. Boyer (1988) documented 15 taxa at Station 0101, including three mayfly families, four stonefly families, and two caddisfly families.

The fish community at Station 0101 consisted of 5 species, and was dominated by fishes common in streams that are transitional between a coldwater and a warm water environment. Blacknose dace *Rhinichthys atratulus* and creek chubs *Semotilus atromaculatus* were the only species rated abundant. Brown trout and bluegills *Lepomis macrochirus*, both rated present, were the sport fish species captured.

In eight minutes of electro fishing at the 90 m long station, the sampling crew captured seven brown trout and three bluegills. The brown trout ranged from 50 mm to 224 mm in total length, and all were wild fish. Of the seven brown trout captured, one (14.3%) was $\geq$ 150 mm in total length. The bluegills ranged from 50 mm to 124 mm in total length, and had probably originated from one of the farm ponds in the drainage.

Station 0102 (River Mile 9.32)

Station 0102 was located in a partially shaded area of stream. Bank erosion was light and the bottom substrate consisted of silt, rubble, and boulders. The station was primarily composed of long, shallow riffles. Overhanging brush, in stream boulders, a few in stream logs, and a few deeper pools provided fish cover.

Physical-chemical parameters and their associated values measured at Station 0102 on July 24, 1991, were as follows: air temperature 38.0°C, water temperature 22.5°C, specific conductance 99 umhos, pH 8.6, total alkalinity 25 mg/l, and total hardness 38 mg/l. Values of physical-chemical parameters at Station 0102 in 1991 were generally comparable to those measured at the station by Boyer in 1987 when seasonally adjusted.

The aquatic macroinvertebrate community was not sampled at Station 0102 in 1991. Boyer (1988) documented 20 taxa at Station 0102, including four mayfly families, five stonefly families, and five caddisfly families.

The fish community at Station 0102 consisted of 12 species, and was dominated by coldwater fishes and species common in streams that are transitional between a coldwater and a warm water environment. Brown trout, creek chubs, white suckers *Catostomus commersoni*, and tessellated darters *Etheostoma olmstedi* were the species rated abundant. Brown trout, rated abundant, and bluegills, rated present, were the sport fish species captured. Brown trout biomass and brown trout number per hectare were 65.46 kg/ha (Class A) and 2,726.5 fish/ha, respectively. The brown trout

ranged from 50 mm to 424 mm in total length, and all were wild fish. Of the 233 brown trout captured, 61 (26.2%) measured $\geq$ 150 mm in total length.

In 49 minutes of electro fishing during the marking run at the 304 m long station, the sampling crew also captured 11 bluegills. The bluegills ranged from 25 mm to 149 mm in total length and had probably originated from one of the farm ponds in the drainage.

Boyer (1988) electro fished a 200 m long stretch of stream located between Stations 0101 and 0102. Only two sub-legal size wild brown trout were captured even though salmonid habitat was considered suitable.

The EV section in the lower Hay Creek extends along the main stem from its confluence with Beaver Run northeast to the Borough of Birdsboro's southern boundary. The following description of this stream section is in the 1993 PA Fish Commission report.

Wild brown trout biomass at Station 0301 in 1991 was estimated at 27.36 kg/ha, a dramatic increase from the wild trout densities documented at this station by Marshall et al. (1977) and Boyer (1988). No reason for this dramatic increase was readily apparent during the 1991 survey, but it may have been related to this site's generally good habitat and a decrease in angling pressure due to the closure of SR 82 and some other nearby access roads following the 1987 flood. Substantial upstream or downstream expansion of this isolated wild trout population would be limited by poor physical habitat.

Station 0301 (River Mile 3.68)

Station 0301 was located in a partially shaded area of stream. Bank erosion was moderate and the bottom substrate consisted of sand, gravel, and rubble in combination with a few beds of *Elodea spp*. The station was primarily composed of long pools, long runs, and short riffles. Undercut banks, in stream boulders, overhanging shrubs, and water depth in the deeper pools provided fish cover.

Physical-chemical parameters and their associated values measured at Station 0301 on July 29, 1991, were as follows: air temperature 21.0^{o}C, water temperature 21.0^{o}C, specific conductance 130 umhos, pH 7.1, total alkalinity 26 mg/l, and total hardness 57 mg/l. Values of physical-chemical parameters at Station 0301 in 1991 were generally comparable to those measured at the station by Boyer in 1987 when seasonally adjusted. Data from Marshall et al. (1977), however, were not comparable to the 1987 and 1991 data. Specific conductance and total hardness measured 410 umhos and 188 mg/l, respectively, in 1977. The reason for the decreases in specific conductance and total hardness measurements from the 1977 survey to the 1987 and 1991 surveys was the cessation of operations at the Grace Mine.

The aquatic macroinvertebrate community was not sampled at Station 0301 in 1991. Marshall et al. (1977) documented 26 taxa at Station 0301, while Boyer (1988) documented only 17 taxa. The number of mayfly families present declined from four in 1977 to two in 1987, but the number of stonefly and caddisfly families present remained constant at two and five, respectively.

The fish community at Station 0301 consisted of 15 species, and was dominated by fishes common in streams that are transitional between a coldwater and a warm water environment. Blacknose dace and white suckers were the only species rated abundant, while migratory American eels were rated present. Brown trout, rated common, brook trout, rated rare, and brown bullheads *Ameiurus nebulosus*, rated rare, were the sport fish species captured. Total brown trout biomass and total number of brown trout per hectare were 43.81 kg/ha and 436.0 fish/ha, respectively. Of the 85 brown trout captured, 76 (89.4%) were judged to be of wild origin and 9 (10.6%) were judged to be stocked fish. Wild brown trout biomass and number of wild brown trout per hectare were 27.36 kg/ha (Class C) and 388.8 fish/ha, respectively. The wild brown trout ranged from 50 mm to 449 mm in total length, with 37 (48.7%) of the fish measuring ≥ 150 mm. The stocked brown trout ranged from 250 mm to 424 mm in total length.

In 48 minutes of electro fishing during the marking run at the 360 m long station, the Sampling crew also captured one brook trout and one brown bullhead. The brook trout Measured between 200 mm and 224 mm in total length, and was judged to be of wild origin. The brown bullhead measured between 175 mm and 199 mm in total length, and had probably originated from one of the farm ponds in the drainage.

The fish community documented at Station 0301 in 1991 was similar to that documented by Marshall et al. in 1977, although the1977 survey documented only nine fish species. Additionally, the 1977 survey captured only 14 brown trout. Boyer (1988) captured only one brown trout while electro fishing in a 200 meter stretch of stream at Station 0301, even though salmonid habitat was judged to be good to excellent. Also refer to Project Area Characteristics, Stream Classification.

2. High Quality Waters

Beaver Run is designated as a high quality, cold water fishery. The PA Fish and Boat Commission prepared the following Fisheries Management Report based upon data sampled in July 1999. Beaver Run, a 5.0 km (3.1 mi) long tributary to Hay Creek in Berks County, was surveyed in 1991 and determined to support a Class A (41 kg/ha) mixed wild brook trout *Salvalinus fontinalis* and brown trout *Salmo trutta* population (Soldo et al. 1991). The brook and brown trout biomass estimates in 1991 were 23.86 kg/ha and 17.26 kg/ha, respectively. Because the combined biomass estimates were close to the 40 kg/ha cut off for a Class A mixed brook and brown trout population the Pennsylvania Fish and Boat Commission's Coldwater Unit requested a resurvey of Beaver Run to determine if the stream maintained a Class A trout population.

One 306 m station, a repeat of the 1991 station, was surveyed on July 28 and 29, 1999. Fourteen fish species were collected during the electro fishing survey. The results of the Chapman Modified Petersen population estimate showed a marked increase in total trout biomass between 1991 and 1999. The total wild trout biomass estimate following the 1999 survey was 56.67 kg/ha. Brook trout comprised 10.94 kg/ha of the estimate while brown trout comprised the remaining 45.73 kg/ha. Two-electro fishing passes resulted in a total catch of 45 brook trout and 125 brown trout. Three brook trout and twenty-one brown trout were of legal length (≥175 mm). Brook trout ranged in lengths from 50 to 224 mm total length (TL) while brown trout ranged in

lengths from 50 to 299 mm TL. Based upon the results of the 1999 survey, Beaver Run should remain on the Pennsylvania Fish and Boat Commission's list of Class A wild trout waters.

B. Wetlands

Wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support vegetation adapted for life in saturated soil, including swamps, marshes, and bogs. Wetlands possess three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology. These soils usually have a high organic content and are frequently acidic. These low pH soils allow a wetland to receive acidic inundations and remain relatively unaffected.

Wetlands in Beaver Run

Skunk cabbage: a wetland Indicator Plant

Wetlands in Hay Creek

Wetland hydrology creates permanent or periodic inundation, or soil saturation to the surface, at least seasonally. The presence of water for a week or more during the growing season typically creates anaerobic soil conditions that affect plant selection and soil development. Numerous factors influence soil moisture including precipitation, groundwater discharge, underlying rock formations, and periodic flooding.

Wetlands have a variety of functions and uses. They can be extremely rich areas for plant growth and animal habitat, often serving as breeding grounds for many organisms. Wetlands are also used as a rest stop, feeding ground, and nesting site for many migratory bird species. These areas absorb floodwaters reducing stream velocity and downstream property damage. Wetlands also filter out pollutants, nutrients, and sediment. Additionally, wetlands provide recreational opportunities for the naturalist. Wetlands should be preserved and maintained not only for their role in improving water quality, but also as key areas to sustain biodiversity and protect rare and endangered species.

Typical wetlands of the Hay Creek headwaters are characterized by numerous small springs and seeps, derived from groundwater. Hydric soils, indicating wetlands, are found throughout the Hay Creek watershed. They are located mainly along the main branch, and are widest where two streams come together. These sections run from Geigertown to one half mile beyond Scarlet's Mill, Joanna Furnace to the conjunction of Cold Run, and the region near Birdsboro Materials Quarry to the confluence with the Schuylkill River.

C. Floodplains

Flooding is a natural and recurring event for a river or stream. Statistically, streams will equal or exceed the mean annual flood once every 2.33 years (Leopold et al., 1964). Flooding is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers, streams, and coastal areas. Water in excess of these capacities causes a watercourse to overflow its banks onto adjacent lands. Floodplains are, in general, those lands most subject to recurring floods, situated adjacent to rivers and streams.

Floodplains will develop natural mechanisms, over time, to reduce erosion and sedimentation, provide floodwater storage and conveyance, and lower flow velocities and flood peaks. These mechanisms help to maintain water quality by filtering nutrients and impurities from runoff, processing organic wastes, and moderating temperature fluctuations. These natural systems also increase groundwater recharge and reduce frequency and duration of low stream flows. Like wetlands, floodplains provide excellent habitats for fish, wildlife, and waterfowl, as well as, protect habitats for rare and endangered species. Floodplain area varies with the topography and stream size increasing with stream order and drainage area.

The Hay Creek floodplain varies in width from 10 to 200 feet or more. It is widest in the valley bottomlands. The floodplain is negligible in the headwaters and other steep narrow valleys. Much of the floodplain is wooded or features hydric soils with natural wetlands vegetation. Little flooding occurs where the forest cover remains in place. The broader valley between Geigertown and Scarlet's Mill is nearly level and subject to greater flooding.

Hay Creek after heavy rains

The Federal Emergency Management Agency (FEMA) delineated the majority of the Hay Creek 100 year floodplain. These areas are known and mapped. Local building ordinances should prohibit permanent structures in the floodplain to reduce loss of life, property damage and insurance costs, as well as, lower the public financial burden incurred to repair or replace uninsured properties damaged in catastrophic flood events.

D. Lakes and Ponds

Lakes and ponds do not occur naturally in the watershed. The largest impoundments in the Hay Creek watershed are manmade. Glen Morgan Lake, also known as Grace Mines Tailings Pond, is a 138-acre impounding basin. Bethlehem Steel as part of their Grace Mine operation constructed the lake. The lake is the centerpiece of Carr's Recreation Park, a 500-acre outdoor activities park

featuring mountain biking, boating, in-line skating, and a driving range, nature trails, sports fields, and a full-facility picnic area. (Please note independent sources have said this park has been closed in 2003. A machine saying the mailbox was full answered Telephone calls to the office number.) Glen Morgan Lake is also an Important Bird Area (IBA). According to the Audubon Society, it is a highly productive wetland habitat in the Piedmont region, shallow with thick emergent vegetation and open water rich in submerged aquatic plants and invertebrates. Ruddy Ducks have been recorded breeding at this site, as well as the largest known breeding colony of Pied-billed Grebes in Pennsylvania.

Stinson Reservoir

The Birdsboro Reservoir, also known as Indian Run, is approximately eight acres and has a capacity of 37 million gallons. The E. & G. Brooke Iron Company built the reservoir in 1883 to supply water for the Borough of Birdsboro. Indian Run was dammed, and fed by a network of twelve to thirteen springs in the reservoir, or flowing into it. Following the construction of the Birdsboro Reservoir, the Brooke's constructed Stinson Run Reservoir in 1892 to supplement municipal water supply. This occurred after the Indian Run impounding breast gave way on June 6, 1892. Before the winter of 1893-1894 set in, the repairs to the reservoir-impounding dam were completed within about 4 feet of its intended height and it was decided to postpone any further work until the following spring. The bursting of a pipe projecting through the impoundment probably caused the breaking of the dam. This resulted in a great deal of damage to pipe lines, roads and bridges. On December 18, 1899, The Board of Directors of the E. & G. Brooke Iron Company passed a resolution that the Water Works be incorporated under the name of the Birdsboro Water Company, and on March 19, 1900, the Birdsboro Water Company was incorporated under the laws of the Commonwealth of Pennsylvania. ("Birdsboro First" The Birdsboro Reservoir, The Birdsboro Water Company) In 1964 the Birdsboro Municipal Authority purchased the water system from the Birdsboro Water Company. The old Dyers at Trap Rock quarry hole now holds water also used for drinking.

Numerous privately owned small ponds range in size from <1 acre to >5 acres. Some of these were built as farm ponds or fishponds and they furnish recreation and water supply for use in fire fighting, watering plants and crops, or watering livestock. Some existing historic ponds were built for waterpower to run grist and saw mills. These mill ponds were connected to a stream by a system of races, a head race to carry water to the pond, and thence to the mill wheels or turbines, and a tail race that carried the water from the mill back to the stream at a lower level. These primitive waterpower systems were actually quite sophisticated, as they required intricate engineering to determine the exact place along the stream to start the millrace so it carried

sufficient water and entered the mill at the right level to provide an adequate head and force to turn the waterwheels.

E. Water Quality

Water Quality Assessment

In 1997 the Pennsylvania Unassessed Waters Program was initiated by DEP to evaluate wade able streams on a local scale while progressing towards a complete statewide assessment of Pennsylvania's water quality within ten years, including the documentation of Point Source and Non-Point Source impairments and their causes. The state was divided into manageable assessment regions based upon the 104 State Water Plan (SWP) watershed management units. The Hay Creek – Tulpehocken Creek region - is designated Section 3C, which represents the Schuylkill River Watershed between Reading and Birdsboro.

Assessment for this region shows that the Hay Creek Watershed has good water quality, with all streams meeting standards for their use designation. The overall drainage of Hay Creek watershed is 14,186 acres. Nitrate concentrations are well below the MCL of 10 mg/L, which indicates fairly low levels of nutrients in the Hay Creek. The Hay has a mean/median value of about 7.1 for pH, which is typical of most rivers in the northeast region and is neither too basic nor acidic.

Biological monitoring of a stream serves to determine the relative health of the aquatic environment by determining the biodiversity of the habitat and the percentage of sensitive organisms that are found there. Bottom dwelling aquatic insects called *benthic macroinvertebrate organisms* are used as indicators of water quality. These insects as a group are wide ranging in their sensitivity to physical and chemical changes in their habitat. Ranking each kind of insect's sensitivity on a scale allows its use in interpreting the health of the stream. Indexes have been developed to rate a stream based on the pollution tolerance of its bug population, and to compare the numbers and varieties of types of invertebrates.

1. Point Sources

The Birdsboro Municipal Authority has an NPDES permit for its sewerage treatment plant. It is located along the banks and discharges into the Hay Creek, near its confluence with the Schuylkill River. A PA DEP official said the plant is at capacity. There is a problem with infiltration – borough resident's sump pumps and gutters tied into the storm water system. The Borough will either have to address this problem or expand its plant. In addition, High Point Baptist Chapel, Bridgeview Incorporated, and Exxon have NPDES permits to discharge into Hay Creek. Haines and Kibblehouse also discharges into Hay Creek under its mining permit. Morgantown Properties have a permit for discharge of Glen Morgan Lake, an industrial waste tailings impoundment. The lake has an under drain system, with seepage discharge into Hay Creek.

TABLE 9. NPDES Water Discharge Permits into Hay Creek.		
Sub Watershed	**Source Name**	**Permit #**
Upper Hay	Bridgeview Inc.	PA0088072
Upper Hay	High Point Baptist Chapel	PA0087173
Upper Hay	Glen Morgan Lake (discharge Tailings Pond)	PAG053512
Lower Hay	Exxon Mobil Corp	
Lower Hay	Haines and Kibblehouse Birdsboro Materials Inc	Part of mining permit
Lower Hay	Birdsboro Municipal Authority	PA0088072

NPDES air release permits have been issued to Haines and Kibblehouse, Inc./Robeson Township Quarry (NPDES - PA0993580; 06-031113), Beacon Container, Corp (PA0955060), Birdsboro Alloying 1/Const, Birdsboro Ferrocast, Inc. (PAD002332344), and F.M. Brown and Sons.

2. Non-Point Sources

Point source pollution can be traced to a definite point of origin, such as a discharge pipe. Non point source pollution covers every other type. For example, pollution caused by erosion and runoff from farms, businesses and residential properties are non-point sources of stream degradation. Pollutants can be nutrients, such as nitrogen and phosphorus that are used in fertilizers used on farms, lawns and golf courses. Nutrients can also come from manure and human wastes. Nutrient management practices can reduce these causes of pollution that produce excessive plant growth in streams and ponds.

Probably the greatest non-point pollutant in the Hay Creek watershed is sediment, small particles of soils or other insoluble materials washed into the stream after rain and storm incidents. Every significant rainfall induces runoff and erosion that results in muddy stream conditions in the Hay Creek. Large storms and downpours that produce flooding can result in serious damage to the stream banks and the streambed. Although heavy rains cannot be prevented, stormwater controls can minimize the amount of sediment that enters the stream under normal conditions. Conservation best management practices on farms, erosion and sedimentation controls at all earth moving sites, detention basins in residential developments, use of streamside buffers of natural vegetation, and enactment and implementation of stormwater management ordinances are measures that address sediment loading in streams.

In the Geigertown region, there are a number of residents who have on lot septic system problems. Robeson and Union Townships are investigating how to correct this problem.

3. Monitoring

Over the years various agencies and organizations have conducted studies of stream aquatic life and physical characteristics in the Hay Creek watershed. The stream has been assessed after known pollution events, to determine health of stream and fish ecology, as an evaluation for

consideration of special waters protection, as part of the PA Unassessed Waters program, source water assessment and protection studies, and as an educational tool. See Table 11 for list of agency studies.

TABLE 10. Stream Monitoring, Surveys and Studies.

Date	Description	Agency	Monitor
1956	Hay Creek Stream Survey Report	PFBC	R. Bielo and N. Sickles
1973	Reading Railroad, Hay Creek	EPA	Region III
1974	Aquatic Biology Investigation, Hay Creek	PA DER	R. Frey
1975	Bethlehem Mines and Hay Creek	PA DER	R. Frey
1977	Hay Creek Stream Survey Report	PFBC	R. Marshall, C. Emery, J. Earle, Carey
1978	Aquatic Biology Investigation, Hay Creek	PA DER	R. Frey
1982	Hay Creek Stream Survey Report	PFBC	C. Emery, Neiswinter
1983	Unnamed Trib. to Hay Creek Pollution Rpt	PFBC	A. Ziegenfus
1988	Aquatic Biology Investigation, Hay Creek	PA DER	M. Boyer
1991	Beaver Run Fisheries Management Report	PFBC	J.S. Soldo, M.L. Kaufmann, B.A. Chikotas
1999	Beaver Run Survey	PFBC	D. Miko

In addition to the above agencies, organizations such as the Berks County Conservancy (BCC) and Hay Creek Watershed Association (HCWA) have established water quality monitoring stations in the Hay Creek watershed. The BCC's efforts have been project specific, where the HCWA is working on an ongoing basis with the Schuylkill Riverkeeper Network (SRN). The Berks County Conservation District (BCCD) supports the HCWA through grant writing assistance. For example, the BCCD's Watershed Specialist recently wrote a grant through the National Fish and Wildlife Foundation's Delaware Estuary Grant Program, which is for water quality monitoring probes. The probes will be available for the HCWA and any other watershed group in Berks County. These probes will benefit HCWA's monitoring program by ensuring high quality data. Should their monitoring kits detect a change in a certain parameter, the data could be verified with these probes and action could be taken. The grant will be announced September 15, 2003. The BCCD and DEP also assist in facilitating training sessions for volunteers, as well as disseminate information from state agencies to local groups.

SRN has a sophisticated Technical Advisory Committee and an agency-approved Quality Assurance Quality Control Plan and meets annually with volunteer monitors to review protocols and refine volunteer skills. They also publish a monitor newsletter, *River Monitor*, to further educate monitors about techniques and current monitoring issues and events. SRN serves as a Steering Committee member for the Keystone Watershed Monitoring Network (KWMN) for Pennsylvania and the Citizens' Advisory Committee for the Delaware River Basin Commission (DRBC). In these roles, SRN has represented the grass roots and helped develop training workshops for volunteer monitors, make strides to improve the use and reliability of volunteer

data, and raise awareness of the power and necessity of volunteer-collected data. Finally, SRN's Monitoring Program is part of the newly formed Consortium for Scientific Assistance to Watersheds (C-SAW). This partnership with United States Geological Survey, Alliance for Aquatic Resource Monitoring, Stroud Water Research Center, Canaan Valley Institute, and Riverkeeper is available to assist local watershed groups in Pennsylvania with a wide array of technical services including volunteer monitoring.

Data is collected using LaMotte kits, which are replenished with new reagents on an annual basis. Specific kit specifications and accuracies are outlined below:

TABLE 11. LaMotte Kit Specifications.

Parameter	Code	Accuracy
Dissolved oxygen	5860	+/-0.2 mg/L
Temperature	1066	+/-0.5 °C
Nitrate-nitrogen	3119	+/- 0.2 mg/L
Ortho-phosphate	3119	+/- 0.2 mg/L
pH	2117	+/- 1.0 pH unit
Turbidity	7519	+/- 5 JTU

E. Water Supply

PA DEP's Bureau of Water Resources Management's database lists permitted surface/groundwater withdrawals in the Hay Creek basin. Permits for public water withdrawal have been issued to the Birdsboro Municipal Authority and the Philadelphia Suburban Water Company, (who purchased former Geigertown Water Company). Haines and Kibblehouse petitioned to found the Birdsboro Heights Water Company. They drilled three wells in anticipation of a future housing development on Chestnut Hill, one of which is contaminated. H&K has approached BMA to take over these wells. The remaining permitted withdrawals include a surface withdrawal for irrigation (Weavers Orchard, Inc.) and a groundwater withdrawal for industrial usage (Hydro-Temp, Inc.) (DEP 1999).

Groundwater Supply

The water bearing characteristics of the rock formations underlying Birdsboro reveal the necessity of the present public water system. The lithology of the Borough is sandstone and shale diabase that provides only a fair yield. The average yield is 50 gallons per minute, which is generally considered inadequate for high-density area. Range of yield - 5 to 300 gallons per minute. Chemical quality of water is generally hard. (Birdsboro 1972).

1. Public/Private

The Borough of Birdsboro has the largest public municipal drinking water system in the Hay Creek watershed. As described in previous sections, the Birdsboro Municipal Authority owns and manages the water resources for Birdsboro residents and some additional customers. The Indian Run and Stinson Run Reservoirs, Dyers Quarry at Trap Rock, and Hay Creek are the water sources. Water collected at the intakes is piped to the Indian Run Reservoir on Long Hill,

Robeson and Union Townships. From here it is gravity fed into the BMA's plant for treatment. The plant is designed to treat 1 MGD, but typically treats only 0.5 MGD. Water treatment includes disinfection, manganese removal, taste and odor control, coagulation and sedimentation, filtration, and corrosion control. The area surrounding the BMA intakes is primarily forested.

Indian Run Reservoir

Philadelphia Suburban Water Company (PSWC) purchased the former Geigertown Water Company. The water source is well water. However, because the current well is located on French Creek State Park property, PSWA has received an emergency permit (extended several times) until they re-drill a second well. This well will be located outside the park, 20-25 feet from the first well. As part of the permit, they will likely need to abandon the first well and fill it with concrete. PSWC provides water for the Village of Geigertown and surrounding area.

Small public water sources that do not require permits are a sandwich shop in Geigertown (1 well), the High Point Baptist Academy (1 well), High Point Baptist Campgrounds (3-4 wells), and Plow Church. There may also be one individual well under seasonal use at the Miniature Golf Course along Route 10, New Morgan. Other wells are privately owned.

2. Well Head Protection Areas

As required under the federal Safe Drinking Water Act, the Commonwealth of Pennsylvania, through the Bureau of Water Supply Management of the Department of Environmental Protection (DEP), has developed a Wellhead Protection Program to protect ground-water sources used by public water systems from contamination that may have an adverse effect on public health. Participation in the program is voluntary and builds upon the basic requirements for water purveyors to obtain the best available source and to take the appropriate actions to protect the source, thereby ensuring a continual and safe water supply. The Wellhead Protection Program will suffice for the ground-water component of the Source Water Assessment Program that is also required to be developed under the Safe Drinking Water Act.

The focal point of a local wellhead protection program is the wellhead protection area delineation as depicted on a map. The Pennsylvania Safe Drinking Water Regulations define a three-tiered wellhead protection area. Zone I is the innermost protective zone which ranges from a 100 to 400 feet radius depending on source and aquifer characteristics. A calculated fixed radius method is used to determine Zone I, which for new wells must be owned or controlled by the water supplier. Zone II is the capture zone, which by default is a ½ mile radius around the source unless a rigorous hydrogeologic delineation is performed. Zone III is the area beyond

Zone II that contributes recharge to the aquifer within the capture zone. Collectively, Zones II and III constitute the contributing area of a well. Cooperative studies conducted by the U.S. Geological Survey (Risser and Madden, 1994; Risser and Barton, 1995) have yielded a strategy that involves the formulation of a conceptual ground-water flow model, selection of a delineation method consistent with the conceptual model and stepwise refinement for rigorous wellhead protection area delineation in the diverse hydrogeologic settings of Pennsylvania. The level of delineation used in a local program is intended to be commensurate with the intended management approach for the wellhead protection area. (http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/srceProt/final_WHPP_htm)

There are currently no wellhead protection areas in the Hay Creek watershed.

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V. BIOLOGICAL RESOURCES

A. Wildlife

1. Terrestrial

The Hay Creek watershed supports a variety of plants and animals. The white tailed deer, fox, groundhogs, raccoons, opossum, mink, muskrat, squirrels, chipmunks, rabbits, shrews, mice, moles, skunks, and voles, bats, toads, snakes, salamanders, turtles, bees, mosquitoes, walking stick, praying mantis, ants, spiders, beetles, springtail, and other insects, butterflies, moths and larvae are examples of wildlife.

In addition, the following species of birds are in the Hay Creek watershed: Common Loon, Pied-billed Grebe, Horned Grebe, Red-necked Grebe, Great Blue Heron, Green Heron, Canada Goose, Wood Duck, American Black Duck, Mallard, Turkey Vulture, Black Vulture, Bald Eagle, Osprey, Sharp-shinned Hawk, Coopers' Hawk, Northern Goshawk, Red-shouldered Hawk, Broad winged Hawk, Red-tailed Hawk, Ruffed Grouse, Wild Turkey, Sandhill Crane, Solitary Sandpiper, Spotted Sandpiper, American Woodcock, Mourning Dove, Black-billed Cuckoo, Yellow-billed Cuckoo, Eastern Screech Owl, Great Horned Owl, Chimney Swift, Ruby-throated Hummingbird, Belted Kingfisher, Red-bellied Woodpecker, Yellow-bellied Sapsucker, Downy Woodpecker, Hairy Woodpecker, Northern Flicker, Pileated Woodpecker, Olive-sided Flycatcher, Eastern Wood-Pewee, Acadian Flycatcher, Least Flycatcher, Eastern Phoebe, Great Crested Flycatcher, Eastern Kingbird, Northern Rough-winged Swallow, Blue Jay, American Crow, Fish Crow, Black-capped Chickadee, Carolina Chickadee, Tufted Titmouse, Red-breasted Nuthatch, White-breasted Nuthatch, Brown Creeper, Carolina Wren, House Wren, Winter Wren, Golden-crowned Kinglet, Ruby-crowned Kinglet, Blue-gray Gnatcatcher, Eastern Bluebird, Veery, Gray-cheeked Thrust, Swainson's Thrush, Hermit Thrush, Wood Thrush, American Robin, Gray Catbird, Brown Thrasher, Cedar Waxwing, European Starling, White-eyed Vireo, Solitary Vireo, Yellow-throated Vireo, Red-eyed Vireo, Blue-winged Warbler, Golden-winged Warbler, Tennessee Warbler, Orange-crowned Warbler, Northern Parula, Yellow Warbler, Chestnut-sided Warbler, Magnolia Warbler, Cape May Warbler, Black-throated Blue Warbler, Yellow-rumped Warbler, Black-throated Green Warbler, Blackburnian Warbler, Yellow-throated Warbler, Pine Warbler, Prairie Warbler, Palm Warbler, Bay-breasted Warbler, Blackpoll Warbler, Cerulean Warbler, Black and White Warbler, American Redstart, Prothonotary Warbler, Worm-eating Warbler, Ovenbird, Northern Waterthrush, Louisiana Waterthrush, Kentucky Warbler, Common Yellowthroat, Hooded Warbler, Canada Warbler, Yellow-breasted Chat, Scarlet Tanager, Northern Cardinal, Blue Grosbeak, Indigo Bunting, Eastern Towhee, American Tree Swallow, Chipping Sparrow, Field Sparrow, Fox Sparrow, Song Sparrow, Swamp Sparrow, White-throated Sparrow, Dark-eyed Junco, Red-winged Blackbird, Rusty Blackbird, Common Grackle, Brown-headed Cowbird, Baltimore Oriole, Pine Grosbeak, Purple Finch, House Finch, Red Crossbill, Pine Siskin, American Goldfinch, Evening Grosbeak, And House Sparrow. (Hay Creek Watershed, Berks County, List 1e Species List)

2. Aquatic

Frogs, salamanders, turtles, dragonflies, damselflies, and stoneflies grace the waters. The PA Fish and Boat Commission have identified the following fish species in the Hay Creek (July,

1991) and Beaver Run (July, 1999): Brook trout, Rainbow trout, Brown trout, Rosyside dace, Cutlips minnow, Common shiner, Swallowtail shiner, Spotfin shiner, Blacknose dace, Longnose dace, Creek chub, Fallfish, White sucker, Northern hog sucker, Yellow bullhead, Brown bullhead, American eel, Rock bass, Redbreast sunfish, Green sunfish, Pumpkinseed, Bluegill, Largemouth bass, Smallmouth bass and Tessellated darter.

Aquatic macroinvertebrate taxa collected at Stations 0103,0302, and 0303 of Hay Creek by the PA Fish and Boat Commission in July of 1991 are: Ephemeroptera (Heptageniidae, Siphlonuridae), Plecoptera (Capniidae, Perlidae, Perlodidae), Coleoptera (Dryopidae), Trichoptera (Hydropsychidae, Philopotamidae, Polycentropodidae), Odonata (Aeshnidae), Diptera (Chironomidae, Tipulidae), Megaloptera (Corydalidae, Sialidae), Hemiptera Gerridae), Decapoda (Cambaridae), Amphipoda (Gammaridae), Plesiopora, Opisthopora, and Class Gastropoda.

Anglers at Rustic Picnic Park

B. Vegetation

NLT reports that the predominant forest type of the Hopewell Big Woods (which includes the forested areas of the Hay Watershed) is Fike's (1999) Dry oak-heath forest. At lower elevations and on richer sites, the Red oak-mixed hardwood forest becomes more common. The only other significant upland forest communities in the Hopewell Big Woods are Red maple (terrestrial) forest and Tulip tree-beech-maple on richer sites. Fire exclusion, lack of soil disturbance, soil eutrophication, and over browsing by White-tailed deer have probably contributed to this trend, with over browsing by White-tailed deer as the likely dominant impact.

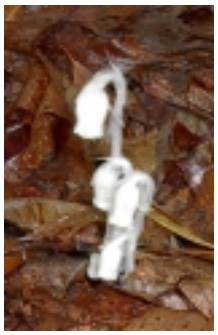
NLT observes that today the richest examples of Dry oak-heath forest occur on ridge top locations on the lands of the Birdsboro Municipal Authority in the lower Hay Creek valley.

Mountain Laurel.

Spice bush, blueberry, iron wood, maple leaf viburnum, sassafras, dogwood, Mountain laurel, Mountain Azalea, are (Rhododendron) are examples of understory shrubs and trees found in the watershed.

Sassafras.

Wildflowers observed include Hepatica, Bloodroot, Canada Mayflower, Mayapple, Rue Anenome, Spring Beauty, Trailing Arbutus, Lady's Slipper, Fringed Polygala, Partridge Berry, Blue Eyed Grass, Forget Me Not, Daises, Indian Cucumber Root, Indian Pipe, Rattlesnake Plantain, Skunk Cabbage, False Hellebore, Ferns, Mushrooms and fungi.



Hepatica, ferns, and Indian pipes found on the forest floor in the Hay Creek watershed.

C. PNDI Species

In the vicinity of White Bear (Scarlet's Mill) in Robeson Township, three plant species of special concern grow. Two of these mark fair and poor populations, respectively, of two wildflower species under consideration for state listing that grow along an abandoned railroad track in dry, open conditions. One species grows at the base of a rock outcrop in association with orange-grass (*Hypericum gentianoides*), bird's-foot violet (*Viola pedata*), frostweed (*Helianthemum canadense*), beard grass (*Schizachyrium scoparium*), and hair-like bulbostylis (*Bulbostylis capillaris*). Another specie of special concern grows in three open areas adjacent to the tracks in association with wild sensitive plant (*Cassia nictitans*), smooth tick-trefoil (*Desmodium laevigatum*), dwarf sumac (*Rhus copallina*), Queen Anne's-lace (*Daucus carota*), Canada goldenrod (*solidago canadense*), and others. For the time being, the plants appear secure. The third plant of special concern grows in an abandoned cow pasture along a branch of Hay Creek in Robeson Township. A fair population of this wildflower, under consideration for state listing, grows at this site with beardgrass (*Andropogon glomeratus*), short-hairy goldenrod (*Solidago*

puberula), and bastard toadflax (*Comandra umbellata*) among others. The wildflower, capable of surviving grazing, could be threatened by succession unless the field is periodically mowed (BCPC 1991).

D. Important Habitats

The Hay Creek watershed is home to communities of plants and animals that depend upon the health of the environment for their continued existence. We can look to the diversity of native plants, wild animals and aquatic species as indicators of environmental health for the larger community of living things, including humans. Biological diversity encompasses the variety of life and the web of interrelationships among living things and their environments.

Transitional Meadow.

Woodland supports wildlife.

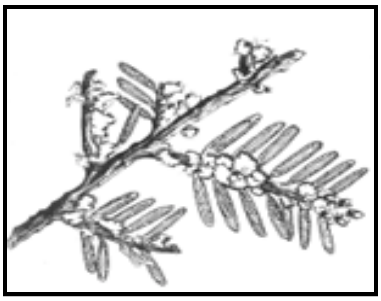
Plants and animals exist in habitat communities, such as different types of forests, wetlands, and grassland regions. Diversity in biological communities promotes stability and equilibrium. Lack of diversity reduces stability, as in a large area of land planted in a single crop that can be devastated by insect or fungus diseases. In a diversified area of plants, this threat is minimized. For example, during the past century, two major tree species were decimated, the American chestnut, in the early 1900s and the American elm, in the mid-1900s, yet the character of the forest maintains its vigor. A pest that is currently a threat to Hemlock Trees is the Woolly Adelgid.

The hemlock woolly adelgid, *Adelges tsugae Annand*, has been recorded as a pest in Oregon, California, Virginia, Delaware, Maryland, New York, and Pennsylvania. Generally, this pest has not caused severe damage in the western United States. However, in eastern Pennsylvania it has caused significant damage to ornamental plantings of Canada hemlock, Tsuga canadensis.

The most obvious sign of a hemlock woolly adelgid infestation is the copious masses of white filaments of wax produced by females. These "cottony" masses normally persist throughout the season and into the following year, even after the insects are dead.

Moderate hemlock woolly adelgid populations may cause a reduction in tree health. Severe infestations may result in premature needle drop, reduced twig growth, dieback, or death of trees. The hemlock woolly adelgid is *not* a significant threat to the forests in the Hay Creek watershed.

Less than 3% of the watershed consists of evergreen forests compared to deciduous forestland that makes up nearly 70% of the watershed.



Hemlock woolly adelgid "cottony" masses

Biological communities of natural vegetation yield many benefits. They furnish habitat for a wide variety of wildlife, provide protection against floods, replenish groundwater supplies, prevent erosion on slopes and uplands, and aid in reducing air pollution.

VI. CULTURAL AND RECREATIONAL RESOURCES

A. Recreational

1. Use/ Type/ Facilities/ Kind

The Hay Creek watershed is characterized by vast amounts of forest, agricultural lands, boulder fields, waterways, trails and open space. This setting lends itself well for the outdoorsman and passive recreation enthusiasts.

Rock climbers cling to the stone cliffs in the former Dyers Quarry at Trap Rock. This site is recognized by both local climbers and out of state visitors. The following description is listed on the Internet under the website http://www.rockclimbing.com: *Birdsboro quarry is a neat little place to climb if you like short sport routes. The approach is an easy ten-minute walk from your car. It's a popular area with a fairly extensive history. On any day with nice weather you'll usually find a few parties using the area along with hikers. The difficulties range from through the whole spectrum from easy to very hard making it a place where beginners and experts alike can find a challenge. The rock quality varies from place to place and helmets are recommended.*

Tons of routes from 12' high to around 100'.
Most routes were put up by Bob Perna (reputedly) excellent climbing! Camping at French Creek State Park nearby. No access problems. Birdsboro – First Section is the area you come to first when entering the crag. It has eleven routes, with names such as The First Climb, Angry White Man, Monkey Boy, Hognose and The Faint. The second area, second spot you come to, has five routes. The big wall has 8 routes. A description of Orange Sunshine: *Sweet crack to a flake; the crux is getting over the flake.* A crack is an inwards split or break in a rock face. A flake is a rock formation where a "flake" of rock sticks out from the rest of the wall. A crux is the most crucial, difficult part of the climb. The Low Wall area includes Neophyte Delight and Dancing Nancy, two real nice beginner climbs.

Climbers at Dyers Quarry

French Creek State Park

Angling in Hay Creek

The region of French Creek State Park west of the Fire Tower on Williams Hill lies within the upper Hay Creek watershed. The 3.6-mile white blazed Turtle Trail, .5 mile red blazed Ridge Trail, and a section of the 130-mile long yellow blazed Horse Shoe wind through this area of state forest. The Horse Shoe Trail also covers open and agricultural lands and parallels Beaver Run in the Beaver Run watershed. Hikers and equestrians frequent the trail. The Horse Shoe

Trail runs from Valley Forge to the Appalachian Trail near Harrisburg. It is the only equestrian trail in French Creek State Park. All trails south of Park Road are closed to mountain bike.

The abandoned section of PA Route 82, which parallels the Hay Creek as it runs through this area, has become an integral part of this area's recreational trail network for a variety of trail users. There are families comprised of all ages – from the elderly to teenagers to toddlers and infants. There are people walking their dogs or riding their horses. There are runners and joggers, and events held by athletic clubs such as the Reading Racers and Delaware Valley Orienteering Club, as well as the Hay Creek Watershed Association and the Berks County Conservancy. The Indian Run, or Birdsboro Reservoir, lined with white pine and surrounded by woodland, is a particularly popular destination.

Hay Creek is known for its trout fishing and is designated a cold waters fishery. Sections are Class A Wild Trout Stream; other areas are stocked. There are native Brook and Brown Trout populations, with Brown Trout being more abundant. The PA Fish and Boat Commission stock Brook, Brown, Rainbow and Palomino Trout. In addition to the Trout, other sports fish species found in the Hay Creek are largemouth bass, small mouth bass, rock bass, brown bullheads, yellow bullheads, bluegills, and redbreast sunfish. Beaver Run also supports native wild brown and brook trout. In addition to the trout, sport species include largemouth bass, pumpkinseed, bluegills and green sunfish.

The Birdsboro Sportsmen's Club and South Birdsboro Archery Rod and Gun Club also stock the Hay Creek in the Rustic Picnic Area for the Annual Children's Fishing Rodeo. The Tulpehocken Chapter of Trout Unlimited, Birdsboro Jaycees, Berks County Conservancy and the Hay Creek Watershed Association have undertaken stream habitat improvement projects. Hunting season brings the archer, trapper, muzzleloader and rifleman to the woods and streams of the Hay Creek valley. Their main prey is deer and small game. Muskrat, mink and members of the weasel family, and snapping turtles are trapped.

Bird watching is another popular activity in the Hay Creek watershed. Birdwatchers from all over the region are attracted to the Hay Creek Valley between White Bear and Birdsboro. This area, due to its complex hydrology, steep topography, rich edge and forest communities, and proximity to the Schuylkill River, has been known to attract a wide variety of migrating and breeding birds since early this century. Earl L. Poole, author of *Pennsylvania Birds, An Annotated List* (1964), and former curator of the Reading Public Museum and Art Gallery, first published ornithological references to Hay Creek in 1930. In 1947, he listed it as one of the eight best year-round bird localities in Berks County. In 2003, it remains one of the most frequently birded areas in the county, especially in spring for migrants and in summer for nesting woodland birds. It has received the official designation as an Important Bird Area (IBA). The Glen Morgan Lake, New Morgan, in the upper Hay Creek watershed is also designated as an IBA. It supports a breeding population of pie-billed grebes. (Pa IBA, 1997). (Berks County Conservancy 1999).

Another outdoor activity gaining in popularity is Geocaching. The word Geocaching broken out is GEO for geography, and CACHING for the process of hiding a cache. Geocaching is an entertaining game for Global Positioning System (GPS) users. A GPS unit is an electronic

device that you use to determine your approximate location (within 6-20 feet) on the planet. Coordinates are normally given in Longitude and Latitude. Participating in a cache hunt can be enjoyed by people of all ages. The basic idea is to have individuals and organizations set up caches all over the world and share the locations of these caches on the Internet. GPS users can then use the location coordinates to find the caches. Once found, a cache may provide the visitor with a variety of rewards. All the visitor is asked to do is if they get something they should try to leave something for the cache. Ed Scott hosts two sites in the Hay Creek watershed. Both are located within the Birdsboro Watershed property. These cache sites are known as Furnace *Hill Summit* and *Stately Tree*. A third site, *JQ004-French Creek* is hosted by TEAM Jack Quest, and located in the French Creek State Park. Additional information can be found at the web site: www.geocaching.com.

Geocache and GPS unit

Orienteering is the sport where one, aided by a compass, utilizes his skills to read and relate a topographical map with its physical setting while hunting for hidden control points. Clues are given using geographic features such as hilltops, ridgelines, or reentrants. A reentrant is a small valley, the center of which collects water and funnels it downhill. Specialized detailed orienteering maps with universal codes and event control points are distributed to participants. Orienteering participants are ranked on their speed as well as correctly finding each control point. Events are held at French Creek State Park. The western region of the French Creek West map is in the Hay Creek Watershed. A map is currently being prepared for the Hay Creek watershed area. The Delaware Valley Orienteering Association set up a representative course in the Birdsboro Municipal Authority's land during the Hay 5K festivities in April 2003.

Orienteering Control Point

Identifying macroinvertebrates

Picnicking at the Rustic Picnic Area, French Creek State Park, and neighborhood community parks, wading in area streams, expeditions to observe wild flowers, trees and nature, searching for historic sites and resources, and photography are additional recreation pursuits.

Various organizations and groups hold outdoor celebrations at places such as the Rustic Picnic Area. Often these combine education with recreation. For example, members of Trout Unlimited demonstrate how to cast a fly rod, the Hay Creek Watershed Association lead children to catch and identify macroinvertebrate in the Hay Creek, and the Audubon Society leads a local bird watching and identification trip. Local service clubs include the Rotary, Lions Club, Optimists and Odd Fellows. Members gather to socialize and undertake projects to help the community. Some organizations hold fundraising events including art auctions and carnivals.

In addition to the activities mentioned above, there are a number of facilities and programs for active recreation. See Table 13. There are baseball fields, tennis courts, and parks with playground equipment. There are privately owned camps and sportsmen clubs. Organizations such as the boy scouts and girls scouts teach children and young adults skills such as respecting the outdoors, tying knots, building trails, and archery.

TABLE 12. Fields, Playgrounds, and Community Parks

Municipality	Park	Acres	Public/Private
Birdsboro	Municipal Play lot	0.1	Public
Birdsboro	Texas Ball Diamond	2.0	Public
Birdsboro	Mill Street Ball Diamond	2.0	Public
Birdsboro	Optimist Field	6.0	Public
Birdsboro	Rustic Picnic Area*	5.0	Public
Birdsboro	Tennis Courts	0.1	Public
Birdsboro	Vest Pocket Park	0.7	Public
Birdsboro	Birdsboro Community Center - Main Bird Park	2.0	Private
Robeson	High Point Chapel Church Camp	112.0	Private
Robeson	Green Hills Sportsmen's Club	19.0	Private
Robeson	Geigertown Baseball Diamond	4.0	Private
Robeson	Wesley-Updike Field	3.0	Private
Union	Maple Spring Swim Assoc.	2.0	Private

* Rustic Picnic Area is mentioned as a passive recreation area.
It also has playground equipment.
** Private clubs and camps have been included. Parks may combine active and passive Recreational opportunities.

B. Archaeological – Historical Resources

Railroads

In 1886, the Pennsylvania Schuylkill Valley Railroad Company built a railroad that paralleled the Schuylkill River through Birdsboro as it connected Philadelphia and Reading and points

beyond. Part of this line is still active and it is now owned by Norfolk Southern and is used by a Robeson Township quarry, Dyer and Company.

The inactive lines are intended for other uses. In the 1990's the rights-of-way of two five-mile segments of the Pennsylvania line were purchased by the Schuylkill River Greenway Association for trail purposes- Douglassville to Birdsboro and Gibraltar to Reading. (See trails section)

The Reading Railroad parallels the Schuylkill River on the north side of the river. The Reading Railroad is now owned and operated by Norfolk Southern and it continues to haul freight. In 1864 a corporation was formed called the Berks and Chester Railroad Company and was authorized to construct branch railroads not to exceed nine miles in length, to extend from the Philadelphia and Reading line near Birdsboro and connect with any railroad in Chester County. In 1866 the railroad was connected with the Delaware and Pennsylvania State Line railroad and the name was changed to Wilmington and Reading Railroad Company, and later, Wilmington and Northern Railroad Company. In 1874, it was 72 miles long and ran from Wilmington to Coatesville to Birdsboro to Reading where it was extended beyond that point by the Berks County Railroad Company. (History of Robeson Township)

The railroad paralleled the Schuylkill Canal from Reading to Birdsboro, and then snaked along the Hay Creek until it reached Scarlet's Mill where it curved sharply into Union Township, then cut back into Robeson at Geigertown. Stations along the way were in Birdsboro, the White Bear, Geigertown, and Joanna.

In 1887 the old Wilmington and Northern served a number of industries along its Hay Creek route: F.M. Weaver Foundry; large E. and G. Brooke holdings, including Hampton Furnace; Peter Bustard (Brown) and Brother Stone Quarry; J. Bower brickyard; Daniel Siegfried gun factory; Scarlet's Grist Mill; Amos Boyer Store; White Bear Tavern; additional grist mills, a factory and two stores in Geigertown; and large holdings of Levi B. Smith and Company at Joanna Furnace. Haines and Kibblehouse use part of this line from its Birdsboro Materials Quarry to Birdsboro. The remainder is abandoned and will be discussed in the trails section of this report.

Trolleys

Horse drawn trolley cars replaced wagons, buggies and stages coaches. Trolley cars were much in evidence during the late 19th century. In 1904, the Black Bear Line was extended to Birdsboro by way of Seyfert and Gibraltar. The last trolley in Robeson Township ended its run in 1934. (History of Robeson Township)

Reactivated Wilmington and Northern Railroad

The Minsi tribe (meaning "wolf") of the Lenape Indians is the earliest known inhabitants of the Hay Creek watershed. European settlement began when King Charles II of England gave William Penn the colony of Pennsylvania in 1681 as repayment for a debt the king owed to Penn's father. In 1718, Penn purchased the rights to all lands south of South Mountain from Indians and by 1720 the first white settlers began arriving in the Hay Creek watershed. The religious tolerance espoused by Penn attracted victims of persecution from all over Europe, Lutherans and Reformists from Sweden and the German principalities settled along the Schuylkill River below Reading among the English Quakers.

Andrew Robeson, a Scot, immigrated here about 1718. He was born in 1654, came to America about 1676, married Maria Helm circa 1690, and died February 19, 1720. He is buried at St. Gabriel's (Old Swedes) Episcopal Church, Douglassville. Robeson was Chief Justice of Pennsylvania between 1693 and 1694. He owned 2,300 acres along the Schuylkill River in what is now Robeson and Exeter Townships. Robeson Township, named after Andrew Robeson, was organized in 1729 (Systems Design Engineering, 1991).

Reading and Birdsboro were the first two towns in Berks County. Birdsboro owes its origin to pioneer William Bird. Bird established the first two iron works in this region and the second in Pennsylvania, dating to 1740. He took up several thousand acres of governmental land to the south to the Schuylkill River stretching along Hay Creek. In the neighborhood of these original iron forges a settlement, now known as Birdsboro, naturally sprang into existence on both sides of the creek (Berks County Conservancy 1999).

Early industry in the watershed centered on Hay Creek. Hay Creek provided plenty of waterpower for the operation of early mills to process grain and timber. The iron industry was one of the most important industries in early times, which is evidenced by Joanna Furnace. Farming has been important since the earliest years of settlement, particularly in the valleys along Hay Creek, Beaver Run, and the Schuylkill River. Quarrying was also important in the later years, which is evidenced by the mines still present.

Historical Resources by Municipality

Borough of Birdsboro

Birdsboro was taken from Union and Robeson Townships and incorporated into a Borough in 1872. It is one of the largest boroughs in the county, approximately one square mile. Since 1883, it has been supplied by water from three reservoirs, located in the hills south of the Borough. Electric lights were installed in 1896. In 1964, a modern sewerage disposal system was installed, and was subsequently updated in 1982. Around 1920 citizens of Birdsboro remodeled the mansion that the founder of the town, William Bird, erected in 1751.

1751 William Bird Mansion

The William Bird mansion has housed the Birdsboro Community Center and YMCA since being renovated. The Brooke Mansion, as well as St. Michael's Church and Alice Focht United Methodist Church, are just a few of the significant structures which date back to the late-1800's (BCC 1987).

Borough of New Morgan

A petition to form the Borough of New Morgan was presented in August 1987. Nestled between Robeson and Caernarvon Townships, New Morgan was formed in January 1992. The borough has a population of 35 with only 12 residences. Due to its close proximity to Joanna Furnace, parts of the borough hold some archaeological significance, and most likely greatly contributed to the iron industry in the early 1800's.

Brecknock Township

People from Brecon or Brecknock, a township in South Wales, originally settled Brecknock Township in southern Berks County. The early settlers included Germans. The township is small, containing about ten thousand acres. The surface is hilly, and the soil is principally gravel. Only a small portion of the township is in the Hay Creek watershed.

Caernarvon Township

Caernarvon Township is situated in the extreme southern section of Berks County. The Welsh named the township. Caernarvon was, and still is, the name of a county in the northern part of Wales (BCC 1987). The township has historical significance, however, only a tiny part of Hay Creek's headwaters are located in the township. Caernarvon Township's cultural resources do not contribute to the historical integrity of the Hay Creek watershed.

Robeson Township

The heart of Hay Creek travels through Robeson Township and into Birdsboro. Settled in 1720, Robeson became a township in 1729. The township was named after Andrew Robeson. Robeson Township is home to several early villages and unique historic structures.

The village of Joanna Furnace, which is being restored by the Hay Creek Valley Historical Association (organized in 1975), is near the headwaters of the Hay Creek. The site is open to the public for guided tours, and each fall is home to the Fall Festival and the Apple Festival. There are Early American Crafts demonstrations, information about the Joanna history and restoration efforts, mechanical technology exhibits, Civil War Encampment, activities for children, homemade food, and music. There are also special events at Christmas. Proceeds benefit the restoration of Historic Joanna Furnace and Hay Creek Valley Association programs.

Joanna Furnace

Joanna Furnace was the product of the iron industry. In 1840, Joanna Furnace was one of eleven furnaces and 36 bloomeries, forges and rolling mills in Berks County producing a total of 9,165 tons of cast iron, and 6,569 tons of bar iron, for a capital investment of $367,444. Joanna alone employed 168 workmen and provided for 1,358 dependent persons. In that year it had 80 horses, used 15,000 cords of wood, and produced 2,200 tons of pig iron and 500 tons of castings. It made use of 21,000 bushels of wheat, rye, and corn, and 78,500 pounds of beef and pork.

The Birdsboro Furnace at Furnace and First Streets, Birdsboro

Patricia Pierce's article entitled "Iron and Copper Mining in Caernarvon Township", published in the *Historical Review of Berks County*, gives a further glimpse into life in the 19th century. She noted that in 1833, the land around Joanna Furnace "*was described as wild and desolate, with inhabitants who seemingly were equally wild. Their occupation was principally that of burning charcoal for the furnace. They were mostly Irish of the clan of Enniskiller, who were Protestants, and the Fordowners, who were Catholic. Times were lively – between the two groups was a never-ending feud*." (History of Robeson Township)

In addition to Joanna Furnace, Geigertown, Plowville, and White Bear (Scarlet's Mill) are among other villages that greatly contribute to the historical significance of Robeson Township.

Union Township

The township was established in 1753. The name of the township arose from a "union" of two sections of territory, one from Coventry Township in Chester County, and the other from Robeson Township in Berks County. Union Township is home to the oldest Methodist Church in Berks County, St. Paul's United Methodist Church. The village of Geigertown is at the boundary of Union and Robeson Townships with the northern half of its buildings in Union Township and the southern half in Robeson. Overall, the village retains its mid-19th century plan. A former Geiger family property contains possibly the oldest barn in the township.

1. Sites/Structures/Districts

A site that has received National Register of Historic Places status is categorized as NR. The National Register's standards for evaluating the significance of properties were developed to recognize the accomplishments of all peoples who have made a significant contribution to our country's history and heritage. The site can be an individual structure, or multiple structures forming a district.

NR Eligible sites are those evaluated to be eligible for the National Register by the Pennsylvania Historic Museum Commission (State Historic Preservation Officer), but whose registration paperwork was not reviewed by the National Park Service. PHMC designation means the property has been surveyed and placed in the PHMC's database. It may be eligible for the National Register. Of those listed in table 14, St. Michael's Protestant Episcopal Church in Birdsboro and the Geiger Mill, Robeson Township are the only individual structures on National Register of Historic Places.

St. Michael's Episcopal Church

The Geiger Mill complex is located in the village of Geigertown in southern Robeson Township situated about 200 feet north of Route 82 along Cold Run Creek. The four historic resources include watercourses (pond and races), and three contributing buildings. The interior of the mill has interesting architectural features including the early floor levels for various types of equipment, stone corner fireplaces on the first and second levels and ladder type stairways. The waterpower for the mill was supplied from Cold Run Creek, which flowed into a pond and then into a headrace, which entered the mill underground on the south side. The water flowed through the wheel pit and the tailrace exited underground on the north side and entered Cold Run Creek near the bridge. The system no longer contains water. The exterior and interior architecture of the mill has changed very little since its construction in 1783. The watercourses no longer contain water but it is possible to determine how waterpower was delivered to the mill from the remains. These changes do not interfere with the essential physical features that enable the historic resources to convey their past identity and character and portray the significant time period 1783 until the mill ceased operations c 1919 shortly after World War I. (National Register of Historic Places – Historic Nomination).

Geiger's Mill

The Joanna Furnace Complex received District honors. From the end of the 18th century and completely throughout the 19th century, the Joanna Furnace Complex was a community of its own with, not only the Furnace itself, but with a store/office, charcoal house, blower/engine house, 15 tenant houses, barns, stables, blacksmith shop, carriage shop and ironmasters' mansion. By the 1870's nearly 6,000 acres of land was connected with the furnace lying together in a great, irregular tract, and situated in Robeson, Caernarvon and Brecknock Townships. At present, the original furnace stack survives along with a large percentage of the raceway, with the blower/engine house and with the store/office building. Also still remaining are the walls and foundations of the charcoal storage building, the casting house and the blacksmith shop. The mansion and barn are now just foundations and are present across the road off the property. The furnace was built in 1792 by Samuel Potts and Thomas Rutter III along the Hay Creek. Exhibiting magnificent masonry, the furnace stands 40' high from a 28' square base. Facing the southeast is the blowing entrance that is surmounted by a huge stone arch. Around the corner to the northeast side, the bosh opens through a smaller stone arch and pyramidal cutout to the remains of the 30' x 40' casting house. The bosh remains intact with little significant damage since its last blast in 1897. To the northwest and the uphill side of the furnace are the remains of a hydraulic elevator that was used to lift ore to the top of the bosh. The furnace was rebuilt in 1847 from the original 28' height to 40' and was probably converted from a cold blast to a hot blast operation. On top of the furnace stack still remains the

mechanical gate to cap the bosh. On the southwest side of the furnace lie the remains of some of the hot blast and water wheel structures. The raceway is visible 60' to 70' from this side and extends out through the property almost to the point where Route 10 crosses the Hay Creek. Further uphill from the furnace lays only the walls of the great charcoal storage building. Again made of sandstone masonry, this structure measures approximately 36' x 62' with walls extending 25' to 30' in height. The huge wall facing the furnace is supported by two large stone buttresses that flank a 10' wide arched doorway that once led to the now vanished covered walkway to the furnace. Both ends of the charcoal house have arched window holes near the peak. The uphill sidewall is now collapsed in the middle. Southwest of the charcoal house remains the icehouse which is now basically a hole in the hill. (National Register of Historic Places – Historic Nomination)

Joanna Furnace

The Hampton Forge/Furnace is an example of a site where the buildings no longer exist. Located in the lower Hay Creek valley, the forge was on Chestnut Hill and utilized the Hay Creek for waterpower. In 1846 Edward and George Brooke erected a charcoal furnace called "Hampton" where the old Hampton Forge had stood, with the object of using their wood to make pig iron in place of operating the forges. One stack, 30 x 8, built in 1846 and rebuilt in 1872, had a closed top and was of the cold blast type. Ore, primarily hematite, obtained in the vicinity of the furnace was used to produce car-wheel pig iron. Capacity was 1500 net tons. Francis Daniel Devlan (1835-1870), a Reading artist, captured the working Hampton Furnace in this oil painting. It is owned and on display at the Historical Society of Berks County.

Painting of Hampton Furnace

TABLE 13. Recognized Historic Sites and Structures in Hay Creek Watershed		
Historic Name	**Register**	**Municipality**
William Bird Mansion	PHMC	Birdsboro
St. Michaels' Protestant Episcopal Church	NR	Birdsboro
Mercantile Building	PHMC	Birdsboro
Mexico	PHMC	Birdsboro
Mill Street Workers Houses	PHMC	Birdsboro
Texas	PHMC	Birdsboro
Levi Focht House	BC	Birdsboro
Lincoln Focht House	PHMC	Birdsboro
Chel Donia Weiler Property	PHMC	Birdsboro
Cora Handwork Property	PHMC	Birdsboro
Friendship Fire Co/Birdsboro D	PHMC	Birdsboro
IOOF Lodge Hall	PHMC	Birdsboro
Alice Focht United Methodist Church	PHMC	Birdsboro
Marian Millard Property	PHMC	Birdsboro
Charles and Margaret Layland Property	PHMC	Birdsboro
F.M. Brown Mill	PHMC	Birdsboro
Bethlehem Steel Property	PHMC	Robeson
Plow Hotel	PHMC	Robeson
Schoolhouse	PHMC	Robeson
David Hoffman Property	PHMC	Robeson
Buck Hollow Road House	PHMC	Robeson
Harold Kurtz Property	PHMC	Robeson
Charles Hamilton Property	PHMC	Robeson
C. Gollub School	PHMC	Robeson
Joanna Heights Camp Meeting	PHMC	Robeson
Blanche Steinmetz Property	PHMC	Robeson
Robert Redzig Property	PHMC	Robeson
Shields Property	PHMC	Robeson
White Bear Tavern	PHMC	Robeson
Lottie Detorre Property	PHMC	Robeson
Irvin Kocher Property	PHMC	Robeson
Plow School	PHMC	Robeson
Geiger Mill	NR	Robeson
WR Updike Property	PHMC	Robeson
Fanny Fry Property	PHMC	Robeson
H. Keinard Property	PHMC	Robeson
Elizabeth Scatchard Property	PHMC	Robeson
Eugene Burkhart Property	PHMC	Robeson
Joanna Furnace Complex	NR - District	Robeson
St. Paul's Methodist Church	PHMC	Union
Geiger Farm	PHMC	Union
Mullen Farm	PHMC	Union
Geiger Farm	PHMC	Union
Geiger's Mill/Geigertown	PHMC	Union
Geigertown Hotel	PHMC	Union
St. James Evangelical Lutheran Church	PHMC	Union
* Schuylkill Canal and Hay Creek Aqueduct		Birdsboro
* Hay Creek Forge	PHMC	Robeson
*Hampton Forge/Furnace at Texas	PHMC	Robeson
* Tilt hammer Forge on Hay Creek		Robeson

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VII. MANAGEMENT OPTIONS

The Management Option section recommends various restoration and maintenance techniques that can be considered for wise stewardship of the natural and cultural resources in the Hay Creek watershed.

A. Goal: Protect and Sustain Water Quality and Water Quantity

1. Riparian Buffers

Establishment of a permanently protected riparian buffer in the watershed is perhaps the best method to protect future water quality. A riparian buffer is the area of natural vegetation maintained adjacent to a stream. It is managed to protect the integrity of the stream channel and reduce the impact of upland sources of pollution by trapping, filtering and converting sediments, nutrients, and chemicals, and to supply food cover. Buffers can be either forested or herbaceous. Forested buffers provide additional benefits by reducing water temperatures in the stream and providing more diverse wildlife habitat.

The greatest loss of riparian buffers occurs through the conversion of farms, forests, and open lands to suburban development. Municipal ordinances can require retention of riparian buffers in developments along stream banks. These ordinances will assure a continuous conservation corridor along the length of a watercourse.

Landowners can voluntarily conserve or restore such buffers. It is also possible to develop a conservation easement program for stream buffers, either through the donation of easements or the purchase of easements. Such a program would designate the width of the buffer strip and provide maintenance guidelines. The guidelines can include recommendations for establishment of wildlife habitat and control of noxious weeds and invasive species.

Specific recommendations:

- Complete a riparian buffer analysis for the entire Hay Creek Watershed.
- Establish native buffers in all areas identified in the analysis.
- Improve existing buffers by removal of invasive species and planting native species.

2. Stream Bank Fencing

Stream bank fencing and animal crossings are the best agricultural practices available to reduce sediment and nutrient loading to streams. These practices offer the most economical method for such reductions. Numerous farms in the Hay Creek watershed pasture livestock along the streams. Cows are commonly seen standing in the stream or crossing from one side to another, breaking down the bank and discharging wastes into the water. This activity increases sediment and nutrient loading to the watercourse. Dramatic improvements to stream water quality are seen almost immediately after fencing and crossings are installed. Numerous incentive programs exist to fund installation of these agricultural best management practices.

Specific Recommendations:

- Inventory all farms in the watershed to determine need for exclusion fencing and animal crossings.
- Contact landowners to ascertain level of cooperation for installation of these practices.
- Determine funding program eligibility for individual landowners.
- Seek funding for farms without other financial aid sources.

3. Water Management

The installation of *best management practices* for water management is recommended in this watershed plan. These practices include barnyard water management, storm water management, and spring development. Collecting rainwater from roofs and impermeable surfaces, directing it away from barnyards, and providing watering facilities for livestock that are out of the floodplain and wetland areas can provide cleaner conditions for the animals, as well as, cleaner water entering the streams. Funding incentives are available.

Water management also includes wastewater treatment and effluent discharge. Well-managed and operated wastewater treatment plants (WWTP) can enhance receiving stream water quality. Conversely, poorly operated treatment plants may reduce stream water quality by addition of excess nutrients and solids. Combined sewer systems, which collect both stormwater and wastewater, tend to wash out wastewater plants during storm events causing illegal discharges of solids and nutrients. These discharges have a negative effect on streamwater quality. WWTP's should be upgraded to comply with current rules and regulations and combined sewers should be eliminated.

Specific Recommendations:

- Inventory all farms in the watershed to determine need for water best management practices.
- Develop conservation plans to address all non-point source pollution problems
- Contact landowners to ascertain level of cooperation for installation of non-fencing AG BMP's.
- Determine funding program eligibility for individual landowners.
- Seek funding for farms without other financial aid sources.
- Design and implement water management BMP's.
- Eliminate all combined sewer systems in the watershed, if any exist.
- Work with municipal governments in the watershed to develop a 20-year plan, if non-existent, for discharge permit compliance and WWTP upgrades.
- Encourage sewer extensions to connect properties with failing or marginal on-site septic system.
- Discourage sewer extensions into new territory since this has a tendency to promote sprawl.

4. Nutrient Management

Under Act 6 of 1999, the Nutrient Management Act, certain agricultural operations are required to have nutrient management plans that specify how livestock waste is managed. The purpose of the law is to prevent pollution from animal feeding operations. Improper nutrient management can be a significant source of ground and surface water pollution. Nutrient management plans are therefore an important tool for protecting water quality. Plans are developed through consultation with the County Conservation District. Cost share funds are available.

Specific Recommendations:

- Inventory farms in the watershed to determine which operations are lacking nutrient management plans according to the law.
- Assist in the development of nutrient management plans for all qualifying farms in the watershed.

5. Stormwater Management

Inadequate storm water management increases flooding, erosion, and sedimentation, and reduces ground water infiltration. Poor storm-water management also increases public facility costs and threatens public health and safety. For these reasons, municipalities are charged with the responsibility of enacting a comprehensive program of stormwater management. Model ordinances have been designed to assist municipalities in meeting these obligations.

Specific Recommendations:

- Inventory commercial, industrial, public and private properties in need of improved storm-water management practices.
- Install demonstration storm-water management best practices at a variety of facilities to increase awareness of benefits of such practices.
- Seek funding for additional implementation of storm-water management best practices.
- Attempt to influence developers to construct and incorporate into the project design appropriate stormwater best management practices.

6. Stream Bank Stabilization and Restoration

Stream banks are vulnerable to erosion as a result of human activities along streams, such as removal of trees and natural vegetation, urbanization, overgrazing of livestock, cultivation too close to the stream, and earthmoving and paving for development. These activities promote changes in stream bank structure, increased sediment, and increased flow of storm-water.

Stream bank stabilization measures can reduce nonpoint source pollution caused by sediment and the contaminants that accompany soil particles into waterways, including heavy metals, phosphorus and other nutrients. These techniques can improve aquatic habitat by reducing the level of suspended and deposited sediments in streams, which impact the ability of fish to breed and reproduce.

A number of programs exist to assist landowners in stabilizing and restoring stream banks. The Berks County Conservancy separately and in conjunction with The Tulpehocken Chapter of Trout Unlimited (TU) specializes in projects to design and implement stream restoration projects. County Conservation Districts conduct a wide range of programs to improve water quality, including improvement of riparian corridors and stream bank stabilization.

A variety of restoration techniques exist depending on the nature and severity of the damage. Steeply eroded banks are frequently lined with riprap with the stone sized according to stream flow. Another technique involves grading, seeding, and matting if equipment has access to the stream banks. The stream toe may be lined with fiber logs to trap sediment and build up a stable foundation for vegetation. Conversely, the toe may be lined with riprap to prevent the stream from undercutting the newly graded bank. Graded and matted banks are seeded with a combination of native grasses and annual rye to anchor the soil until planted streamside vegetation can be established. Trees are typically planted above the bank with the density dependent on existing vegetation and space available.

A wide variety of techniques are available to improve fish habitat. Deflectors may be installed to improve sinuosity in straight runs. Boulders may be placed in the stream to increase ambush and resting spots. A variety of structures may be incorporated into the banks to provide shelter and fish protection. Flow may be diverted or channeled to increase scouring for improved nesting sites. Combinations of techniques are frequently used depending on the target species and stream conditions.

Specific Recommendations:

- Inventory entire water shed to determine need for restoration projects.
- Prioritize restoration projects based on severity of problem and impact of restoration on the watershed.
- Contact landowners to ascertain level of cooperation for stream restoration work.
- Seek funding for projects.
- Design and submit permit applications for projects.
- Implement projects

7. Wetlands Management and Protection

Wetlands are critical resources that provide important wildlife habitat and play a key role in flood prevention, surface water management, groundwater recharge, and ground and surface water quality. Wetlands provide biofiltration, or the removal of sediment and pollutants of ground and surface water.

Hay Creek and its tributaries have wetlands connected to flood plains, as well as, in more remote areas. Wetlands are found in meadows, pastures, woodland, and open space areas. Some of these wetlands provide habitat for species of special concern, and are considered top priorities for protection.

Federal and state regulatory programs protect wetlands by requiring permits for activities in or affecting wetlands. Wetlands management tools may be included in municipal zoning,

subdivision, and land development ordinances. Townships can designate natural resource based zoning overlay districts and nonprofit conservation organizations can work with property owners to protect important wetland areas with conservation easements.

Specific Recommendations:

- Inventory all wetlands in the watershed.
- Determine protection status of all wetlands.
- Define and prioritize protection options for critical wetlands.
- Contact landowners to ascertain level of cooperation for wetlands protection.
- Seek funding for easement purchase or fee simple purchase as appropriate to the situation.

8. Groundwater

Groundwater wells furnish nearly all the drinking water in the Hay Creek watershed, except for the borough of Birdsboro. It is important that this water supply be kept free from pollutants. Activities and land uses that have the potential for harming groundwater include: agriculture, storage tanks, home lawns, golf courses, chemicals used on highways, landfills, quarries, malfunctioning on-lot septic systems, and improper disposal of used motor oil. While the soil acts to filter out harmful substances, an excessive amount of pollutants can overcome the soils self-cleaning capacity. Detection of pollution is difficult and clean up is expensive. Dealing with these issues demands preventative measures to protect groundwater by both government entities and citizens.

Programs that deal with protection of groundwater quality are wellhead protection measures, nutrient management and pesticide regulation. The testing of public water sources is regulated, but the testing of private wells is left up to the property owners. Past surveys in rural Berks County have indicated that a significant percentage of private wells have unacceptable levels of bacteria and nitrates, which require treatment by the homeowners. Unless regular periodic testing is done, most homeowners are not aware of this risk.

The quantity of groundwater is perhaps more of an unknown factor than the quality. There have been very few hydrological studies to determine the amount of groundwater that is available for residential, commercial and industrial uses. Yet a safe and plentiful water supply is essential for any development to take place. Some property owners consider groundwater a major concern, citing evidence of lower well levels and springs going dry. In many areas of the country there are strict water use controls and water rights are valuable commodities. Future growth, as well as, local and regional planning would benefit from increased knowledge of groundwater quality and available supply. Land use development decisions should include an assessment of ground water quantity and quality.

Specific Recommendations:

- Continuously monitor the Conestoga land fill liner integrity, cover, surface runoff, and groundwater discharge.
- Conduct a groundwater study in the watershed to assist in future development and zoning decisions.

9. Continue Water Quality Monitoring

Monitoring of water quality in the Hay Creek, Beaver Run, and associated tributaries was performed by numerous agencies and organizations during the last several years. It is the recommendation of this Plan to continue monitoring water quality and quantity in a way that the sharing and interpretation of data may result in a better understanding of the dynamics of water quality in the stream systems, and correct known problems, and prevent new problems from occurring. The HCWA is revamping their website and plan to include their water quality monitoring data for public use.

Specific Recommendations:

- Develop and implement a continuous water quantity and quality monitoring program in the watershed.
- Evaluate the physical, chemical, and biological water quality in Glen Morgan Lake and determine if remediation or treatment is necessary.
- Evaluate the feasibility of a treatment system for the lake discharge water based on the findings of the above study.
- Evaluate the design and construction costs for a lake discharge treatment system.
- Evaluate the Operations, Management, and Maintenance costs for the lake treatment system.
- Implement remedial actions or treatment according to the findings from the above studies.

10. Improve Impaired Areas

Areas of stream bank degradation, flood damage, or cases of point or non-point pollution should also be identified and addressed. In some situations, a property owner can deal with the problem. In other cases, local or state government assistance may be required.

Specific Recommendations:

- Develop an inventory of all point sources of pollution in the watershed.
- Determine compliance status of all NPDES permit holders in the watershed.
- Address specific permit violations with owners.
- Develop cooperative plan for full time compliance.
- Monitor discharges as necessary to assure compliance.
- Develop inventory of all non-point sources of pollution not addressed in the above sections.
- Develop strategies and implementation options to address these sources of pollution.
- Seek funding as required.
- Implement strategies and options.

11. Upgrade Streams to HQ and EV Classifications

Results of the DEP Stream Quality Assessment revealed that two sections of the Hay Creek support sensitive aquatic life, and qualify as Exceptional Value. Beaver Run has achieved the High Quality rank. Improving and upgrading the cold water fishery sections of Hay Creek from Glen Morgan Lake to the confluence with Beaver Run, and from the Birdsboro Borough line to the confluence with the Schuylkill River should be an ongoing goal. Likewise, water quality enhancements to Beaver Run might upgrade it to Exceptional Value. Gaining Special Protection status for all stream sections that qualify will go a long way toward sustaining water quality in the Hay Creek Watershed.

Specific Recommendations:

- Strive to upgrade the PADEP water quality designation from Cold Water Fishery and High Quality to Exceptional Value

B. Goal: Protect, Preserve, and Enhance Natural and Agricultural Lands

1. Protect Natural Resource Areas

Natural Resource Areas include environmentally sensitive areas such as prominent forest cover, slopes greater than 15 percent, ridgelines, headwaters for streams, springs, seeps, rock outcrops, scenic vistas, and PNDI sites. These areas are important to sustain ecological resources, such as native plants and animals, and also to protect scenic and aesthetic qualities of the watershed. Much of this property is privately owned and not restricted from development.

A combination of municipal action and landowner initiative is recommended to protect high priority natural areas. Overlay zoning or Natural Resource Preservation zoning can restrict those land uses that would compromise the environmental or ecological value of the prescribed area.

A more permanent means of land protection is through a program encouraging the landowner's donation or sale of conservation easements that protect individual properties. Private non-profit land protection organizations such as Berks County Conservancy, Nature Conservancy, or Natural Lands Trust can work with property owners to discuss mutual goals for the long-term protection of such lands.

Specific Recommendations:

- Conduct a Feasibility Study, if necessary, or construct a trail within the watershed to connect the Schuylkill River Trail to Glen Morgan Lake and Elverson.
- Work with landowners to allow public access to Glen Morgan Lake area.
- Develop and construct a wildlife viewing trail and recreation area adjacent to Glen Morgan Lake.
- Assist with the protection of the Hopewell Big Woods.
- Develop a plan to protect forests in the watershed that are not a part of the Big Woods.
- Work with municipalities to enact tree harvest laws that incorporate conservation measures that protect water resources during harvest events.

- Assist with the restoration and preservation of Joanna Furnace and surrounding Historic sites.
- Protect and preserve the wetlands near the Bridgeview Infectious Waste Incinerator.
- Develop an inventory of wetlands, seeps, and springs in need of protection.
- Identify landowners and ascertain level of cooperation and interest in preservation.
- Identify finding sources for wetland protection.

2. Protect Environmental Hazard Areas

Environmental hazard areas are lands that cannot, and should not, be developed because of their proximity to water, slope or soil conditions. Areas in this category consist of slopes greater than 25%, wetlands, floodplains, watercourses, aquifers, and watersheds that supply public drinking water. Although self-limiting to a large extent, these areas should be further protected from development through municipal regulations or ordinances.

New structures and on-site septic systems should be prohibited on slopes of 25% or greater. Growth should be restricted on soils or slopes that have been identified as hazardous for structures with on-lot sewage disposal systems or in areas where geology limits the availability of water from on-site wells.

National Wetlands Inventory maps and hydric soils maps identify areas that may contain wetlands. In addition to restricting any building or development in wetlands, buffer areas should be established to further protect them. In a similar fashion, floodplains should be maintained in natural vegetation with a protective buffer.

Public water supplies should be protected by their municipal owners. A good example is the Borough of Birdsboro, which maintains a 1,800-acre watershed around its two reservoirs on Long Hill and Furnace Hill. This large tract of woodlands, with many springs and seeps, maintains the high quality of the water that is impounded for use by the residents of Birdsboro and vicinity. Publicly owned watershed protection properties should be retained in forest cover. Forestry management principles should be structured to provide optimum protection for the water resources.

Specific Recommendations:

- Check municipal zoning records and ordinances to assure inclusion of all known hazardous areas in conservation zones.
- Work with watershed municipalities and County Planning Commission to assure continuity in conservation zones.
- Correct conservation zoning ranges, if possible, to include sensitive watershed sites.

3. Develop Program to Fund Stream Buffer and Wetlands Protection

Streamside buffer establishment and wetlands protection was recommended to improve water quality in the watershed. However, some landowners are reluctant to forfeit use of these sensitive lands. Additionally, buffer maintenance is perceived as expensive and time consuming.

Specific Recommendations:

- Develop a special funding or management program to encourage landowners to protect buffers and wetlands, and to identify environmentally compatible uses for these areas.

Wetland near Buck Hollow Road

4. Institute Effective Agricultural Preservation

Berks County established an Agricultural Preservation Easement program in order to preserve productive farmland. The Agricultural Preservation Board administers this program. The board adopted specific criteria in order to rank farms for program consideration. Farms are scored on criteria that include soil type, location, productivity, zoning, the presence of other protected farms in the area, etc. The county purchases easements on parcels of suitable farmland, giving priority to parcels located in Agricultural Preservation Areas, where farms are clustered, and where an active farming community exists. Applications from landowners are accepted, ranked, and reviewed on an annual basis. Easements are purchased in descending order from the highest ranked farm. The program is competitive because of limited funds. Presently, there are more interested landowners than money available for easements.

Hay Creek valley farms do not rank as high as those from Berks County's best farming regions, and therefore are unlikely to benefit from this program. Robeson and Union Townships might consider following Centre Township's lead, whose agricultural lands also do not rank as high. In 2002, Centre Township, Berks County adopted a Land Protection Easement Program. Its purpose is to protect agriculture and natural resource lands in areas zoned for agricultural preservation by acquiring agricultural conservation easements and natural resource conservation easements that limit the development or improvement of the lands for any purpose other than agriculture production or acceptable uses in natural areas, respectively.

The County has established an Agricultural Zoning Incentive Program (AZIP), which will give local municipalities technical and financial assistance to encourage them to enact effective agricultural zoning regulations in Agricultural Preservation Areas. Berks County will pay the costs associated with either amending or revising the municipality's zoning ordinance. The Berks County Planning Commission will be the sole judge of whether a municipality has met the standard of effective agricultural zoning. Robeson Township recently adopted an Agriculture District zone.

Specific Recommendations:

- Watershed municipalities should develop an Agricultural easement program independent of the county System.
- This program should involve a joint effort by all municipalities in the watershed.
- An Agricultural Preservation Bond issue should be considered as a source of funding for easements.
- Alternate sources of funding should be considered.

5. Establish Agricultural Security Areas

None of the rural municipalities in the Hay Creek Watershed have established Agricultural Security Areas (ASAs). This program was established under the Agricultural Area Security Law, PA Act 43, in 1981. A landowner or group of landowners whose parcels together comprise at least 250 acres may apply to a municipality for the designation of an ASA. The parcels must be viable agricultural land and may be comprised of non-contiguous tracts of at least 10 acres. The ASA gives a landowner protection from local ordinances that restrict farm practices, protects against nuisance ordinances, and limits land condemnation procedures. The ASA also is a requirement for application to the County-State Agricultural Preservation Program for purchase of agricultural conservation easements. It is not a permanent designation, and is reviewed every seven years.

Specific Recommendations:

- Establish Agricultural Security Areas for all municipalities in the watershed.

C. Goal: Encourage Stewardship of Natural and Cultural Resources

1. Develop Resource Protection Educational Programs

Resource protection is an important issue in the Hay Creek Watershed, as the region is primarily rural, but is undergoing rapid growth and change. Citizens living in the watershed are concerned with issues affecting their quality of life and the degradation of natural and cultural resources. In conducting surveys and talking with local residents during the course of this planning project, it has become apparent that people are very concerned about protecting water quality, learning more about groundwater resources, protecting forests, farmland and natural areas, and preserving the historic countryside. There exists a great need to increase public awareness of resource protection issues through community education, and to foster better communication among all those who have an interest or involvement.

Among those with interest and involvement are private landowners, citizens groups, nonprofit organizations, local government officials, developers, local and state agencies, schools, civic groups, sportsmen's clubs, etc. There are many organizations that can help coordinate educational forums and projects. There is much that can be done in cooperation with the public schools.

In addition to education, there is a need for action programs. When a specific natural resource problem is identified, it needs to be addressed. Coordinated citizen action can be a powerful force to address local concerns.

Specific recommendations:

- The Hay Creek Watershed Association should establish a physical presence in the area to provide education, outreach, and technical assistance to municipalities and citizens.

2. Encourage Identification and Monitoring of Natural Resources

An excellent avenue for citizen involvement in watershed stewardship is the identification and monitoring of natural resources. Not only can this provide valuable data and a better understanding of the status of the resources, but also it enables local citizens and/or students to become active participants in resource protection. Pennsylvania is putting great effort into establishing a Citizen's Volunteer Monitoring Program, believing that volunteers are an essential element in statewide watershed protection and restoration. The state program groups monitoring into two broad categories: *Watershed ecosystem monitoring*, which collects data on characteristics that determine the health and functioning of the ecosystem; and *Monitoring human users and uses*, which investigates characteristics that determine whether the water supports human uses, and whether the uses themselves are supporting public health, safety and welfare. Although monitoring has occurred in the watershed, it has not been coordinated, and its results have not led to the next step – actions to correct problem areas.

Several monitoring efforts in the watershed are underway. The Hay Creek Watershed Association has been monitoring stream sites. The Pennsylvania Audubon Society has been monitoring the two regions defined as Important Bird Areas.

Specific recommendations:

- The Hay Creek Watershed Association should establish a physical presence in the area to provide education, outreach, and technical assistance to municipalities and citizens.
- The Hay Creek Watershed Association should establish a watershed education program targeted to children – preferably within the watershed to promote environmental awareness and watershed stewardship.

3. Develop Outreach Programs for Landowners and Municipalities

This Plan and other watershed plans feature many recommendations concerning actions that can be taken by landowners and municipalities in protecting land, water, biological and cultural resources. Some actions are listed as priorities, and these should be the first to be pursued. To communicate these findings and recommendations to those who can do something about them, it is further recommended that an outreach program be initiated to conduct personal visits to landowners, and to make formal presentations to municipal officials. Such a program could be conducted on a subwatershed level by local citizens groups, or on a municipal level by the Berks County Conservancy. Information and maps from this Plan could be used as points of discussion, and copies could be distributed at these meetings.

Specific recommendations:

- The Hay Creek Watershed Association should establish a physical presence in the area to provide education, outreach, and technical assistance to municipalities and citizens.

4. Encourage Forest Stewardship Plans

Sustainable forestry practices provide both current and long-term benefits to a watershed. Proper timber management encourages the preservation of open space by providing a local landowner with income from standing timber and a market-driven incentive to maintain their property as forestland. Timber management also promotes forest health, lessens the potential of wildfire, protects sites of special significance, provides a rich and diverse wildlife habitat and encourages recreational opportunities.

The Pennsylvania Forestry Stewardship Program assists property owners in managing their forestland for sustained, productive use without having negative impacts on the ecological balance of the forest community. This program helps private landowners better manage, protect and utilize their forests through assisting with the development of multi-resource forest stewardship plans. The landowner's statement of goals and objectives for his woodland forms the foundation of the management plan. It includes a description of the property based on an overall inventory of its resources. The property is then broken into smaller management units, which are inventoried and described in more detail. A map of the property is drawn to illustrate significant features and the forest management units. Finally, there is a list of activities or projects to meet the stated objectives. The Pennsylvania Bureau of Forestry sponsors a cost share program to pay major costs of plan preparation by a professional forester. The French Creek State Park is one of the demonstration sites for the Pennsylvania Forest Stewardship Program. See Appendices.

The Natural Lands Trust is leading the Hopewell Big Woods Partnership Project. The partnership includes DCNR Bureaus of State Parks, Forestry, and Recreation and Conservation, the Game Commission, the National Parks Service, the County of Chester as public partners and The Nature Conservancy, Natural Lands Trust, Berks County Conservancy, French and Pickering Creeks Conservation Trust, Green Valleys Association, Hay Creek Watershed Association, Pennsylvania Audubon Society, Brandywine Conservancy, the Schuylkill River Greenway Association, and Mrs. Eleanor Morris as private partners. NLT is currently writing the Hopewell Big Woods Landscape Conservation Plan. Management strategies outlined here might be applicable for individual forest landowners.

5. Encourage Conservation Plans

Conservation Plans are recommended for working farmland and other large tracts in the Hay Creek watershed. The Natural Resource Conservation Service (NRCS) provides technical assistance to farmers and landowners in the development of Conservation Plans that analyze and map soils, topography, drainage, productive capability and recommend practices to best utilize the land for productive agriculture or to meet the landowner's objectives for their property. Conservation Plans promote good stewardship of the land and water resources that are essential for sustainable agriculture and wise land use.

6. Encourage Enrollment in Conservation Reserve Program

Farmers in Berks County can enroll marginal farmland in the Conservation Reserve Program (CRP) administered by the Farm Service Agency (FSA). The purpose of the program is to improve water quality and wildlife habitat by converting highly erodible land and/or riparian areas from agricultural production to conservation uses. To be eligible, land must have been cropped two of the previous five years, or be marginal pastureland. Participants must agree to establish and maintain eligible practices under a ten to fifteen year contract. CRP practices include planting of permanent grasses, hardwood trees, or wildlife habitat; establishing grassed waterways, filter strips, contour grass strips, or riparian-forested buffers; and restoring wetlands. The Federal Government will pay up to 50% of the cost of installing conservation practices, and an additional annual rental payment based on the soil rental rate per acre as calculated by FSA.

7. Encourage Enrollment in Clean and Green Program

The Pennsylvania Farmland and Forest Land Assessment Act of 1974 (Act 319) provide for preferential assessment of tracts of farmland and forest land over ten acres. To be eligible land must meets qualifications for agricultural use, agricultural reserve, or forest use. If enrolled in the program, land will be assessed at its actual use value, rather than its market value for highest and best use. This usually results in a significant property tax reduction. Application forms are available at the Berks County Assessment Office.

8. Encourage Historic Preservation Initiatives

There is great interest in historic preservation in the Hay Creek watershed. Many owners of historic buildings have expended time, research, and financial investment into restoration of their own unique properties. This region is one of the earliest colonial iron industry historic areas in the Commonwealth. A number of remaining structures and vestiges are a tribute to local entrepreneurs and collectively illustrate the technological advancements over many generations. Joanna Furnace is being restored by the Hay Creek Valley Historical Society and is open to the public several times a year.

Buildings at Joanna Furnace

In addition to interested and knowledgeable property owners, this region has excellent craftsmen, skilled restoration specialists, and experts in fields such as antiques, pottery, genealogy, and historical research. There are several historic preservation organizations – the Hay Creek Valley Historical Association and the Robeson Township Historical Society. Regional organizations

interested in history include the Berks County Historical Society, Berks County Conservancy and Schuylkill River Greenway Association. The Historic Preservation Trust of Berks County, headquartered in Amity Township, is the owner and steward of Berks County's earliest European settlement, Old Morlatton Village. William Bird married one of the Morlatton villagers in the 1700's. All of these individuals and organizations seek to preserve heritage values.

Specific recommendations:

The following is a list of initiatives to augment the ongoing preservation activities in this region:

- Submit National Register Nominations for individual buildings or historic districts, including those that have already been placed on PHMC data base
- Update historic site surveys and inventories
- Publish books, articles and manuscripts dealing with local historic topics
- Appoint Historic Preservation Commissions in townships and boroughs
- Develop municipal Historic Preservation Plans pursuant to Act 68 of 2000
- Develop historic resource overlay districts on municipal zoning ordinances
- Assign and map GIS coordinates to updated historic resource survey. Create and distribute map of historic sites for driving or walking tours.
- Hold hands-on restoration workshops taught by professional tradesmen to explain and teach skills used in restoration work.
- Feature historic resources and stories of Hay Creek watershed in a television series. Stories might include the valley's expansive iron industry, the Underground Railroad, the Schuylkill Canal, etc.
- Preserve the sites and structures related to the historical iron making industry in the Hay Creek Watershed.

Washed out section of Route 82

9. Route 82

Portions of State Road 82 run along the Hay Creek. This road has been closed as a result of a flood in 1987. Development pressures in the area are reduced as a result of the road being closed. Proximity of this area to route 422 and subsequent access to Philadelphia would inevitably lead to increased development if the road would reopen. Increased development will, in all probability, lead to reduction in water quality and habitat.

Specific Recommendations:

- Actively lobby The Pennsylvania Department of Transportation and affected municipalities to keep Route 82 closed.
- Actively seek a public entity to own the Route 82 corridor for permanent protection as a park.

D. Goal: Encourage Regional Planning Initiatives

1. Participate in Berks County Regional Planning Program

Many issues local municipalities deal with are regional in nature, such as planning and zoning, sewer and water provision, agricultural preservation, and transportation. Neighboring municipalities frequently face the same problems; yet do not communicate with one another about them. To improve this situation, the Berks County Planning Commission initiated a Joint Comprehensive Planning Program in 1992. This program has been very successful, achieving participation from many of the municipalities in the county. Since then the County has developed a Joint Zoning program for municipalities that have prepared joint comprehensive plans. The County has also completed a sewer and water regionalization study that explores potential regional solutions to sewer and water provision and infrastructure maintenance. Municipalities in the Hay Creek region could benefit from these programs.

The Borough of Birdsboro and Robeson, Union and Caernarvon Townships are working together to develop a joint Comprehensive Plan. Brecknock has joined other municipalities in its fellow Governor Mifflin school district. New Morgan has chosen to remain independent. The next step after a Joint Comprehensive Plan is a Joint Zoning Ordinance. Ordinances must conform to the Pennsylvania Municipalities Planning Code and must be consistent with the County Comprehensive Plan.

2. Planning on a Watershed Basis

Sustaining the water quality and quantity of the Hay Creek watershed is mutually beneficial for all municipalities. Actions that occur in one area of the watershed have impacts on other areas. Protecting surface and ground water resources is a goal throughout the watershed, and requires intermunicipal communication and cooperation. One example of watershed-based planning involves stormwater management.

The Berks County Planning Commission is undertaking watershed Planning for stormwater management. Under PA Act 167, the Stormwater Management Act, all counties, in consultation

with its municipalities, must prepare and adopt a stormwater management plan for each of its designated watersheds. In Berks County the designated watersheds are: Tulpehocken Creek, Maiden Creek, Manatawny Creek, and Schuylkill River. Within six months following adoption and approval of the plan, each municipality is required to adopt or amend stormwater ordinances as laid out in the plan. These ordinances must regulate development within the municipality in a manner consistent with the watershed stormwater plan. Developers are required to manage the quantity, velocity, and direction of resulting stormwater runoff in a manner that adequately protects health and property from possible injury. They must implement control measures that are consistent with the provisions of the watershed plan and the Act. The Act also provides for civil remedies for those aggrieved by inadequate management of accelerated stormwater runoff.

Development in a watershed causes an increase in stormwater runoff and a reduction in groundwater recharge. A number of negative effects result from uncontrolled stormwater runoff. These include: downstream flooding, erosion and sedimentation problems, reduction in stream quality, increase in stream temperature, impairment of the aquatic food chain, and reduction in the base flow of the stream during the dry summer months. Stormwater management entails bringing surface runoff caused by precipitation events under control. This is not simply a site-specific problem, but requires an understanding of the dynamics of the whole watershed. It involves proper planning, engineering, construction, operation and maintenance.

3. Watershed Conservation Management Plans

The PA Department of Conservation and Natural Resources provides funds for local governments and private non-profit conservation organizations to prepare Watershed Conservation Management Plans on a watershed basis. In 2000 the Schuylkill Watershed Conservation Plan was published.

The Schuylkill Watershed Conservation Plan presents a broad overview of the 1,916 square mile watershed with its primary focus on water quality, landscape sustainability and institutional assessment. It provides a summary of recommendations and issues by subwatershed. It identifies the Hay Creek subwatershed to be of the high-threat category for continued population growth in the next decade. The Schuylkill Plan ranked the Hay Creek watershed "highest priority for habitat protection in the Schuylkill River watershed." Of the 37 sub watersheds in the Schuylkill River watershed, only Hay Creek and the Lower Little Schuylkill had both more than 70% forested land cover and 60% first order stream frequency. The Schuylkill Plan's recommendations for the Hay Creek watershed include:

- Maintain the integrity of the "Reading Horseshoe" habitat zone
- Protect and maintain forest cover
- Protect first-order streams
- Proactively protect PNDI sites

This Hay Creek Watershed Conservation Management Plan provides a more focused overview of this 22.1 square mile watershed of the Schuylkill River. The Plan includes: descriptions and GIS maps of watershed characteristics, a listing of issues and concerns, and management options to address watershed conservation priorities. Inclusion in both Watershed Conservation

Management Plans opens the way for matching implementation grants to carry out recommended projects.

The Berks County Conservancy has now completed Watershed Conservation Plans for the County's major tributaries of the Schuylkill River: Tulpehocken Creek, Maiden Creek, Manatawny Creek and Hay Creek. Future projects will address other Berks County watersheds: Wyomissing Creek, and other Schuylkill River Tributaries. Each plan will seek to identify local concerns and issues and to recommend actions that will meet community watershed goals. All Plans demand follow up actions and efforts to be carried out by a broad spectrum of partners – state, county and local agencies, municipalities, non-profits, schools, and the general public.

Specific Recommendations:

- Conduct a Greenway Feasibility Study in the Watershed
- Develop a Greenway according to the results obtained in the Feasibility Study

E. Goal: Encourage Smart Growth

Municipal zoning boards are encouraged to incorporate the following principals whenever possible into their subdivision zoning ordinances.

1. Location Characteristics

The development is located in an area that is designated as Developed or Planned Growth area in the Berks County Comprehensive Plan.

- § The development is located within or adjacent to an existing developed area.
- § The development is located to make use of existing infrastructure.
- § Existing public facilities, churches, libraries, schools, recreation, retail, and offices are located adjacent or in close proximity to the development.
- § The development offers convenient access to transportation choices.
- § Residences, green space, commercial buildings, and retail establishments are concentrated around a planned or existing transit stop.

2. Site Planning Characteristics

- § The project includes an appropriate mix of land uses, including but not limited to, residential, large site development, commercial, retail, recreational, and civic (dependent upon development size).
- § The streets are designed with curbs, sidewalks, crosswalks, and ground floor uses (commercial sites only, retail/civic core) to support pedestrian-oriented places.
- § Public places are designed to encourage people to participate in commercial, civic, or recreational uses.
- § The design and scale of the buildings and site are compatible with that of existing adjacent structures.
- § The front façades are designed to promote the continuity of a street wall and creates an "outdoor room."
- § Local streets with sidewalks and curbs are organized in an interconnected pattern extending existing street patterns, offering direct access to collector and arterial streets and/or other developments.

- Local streets offer a safe and appealing environment for pedestrians through continuous sidewalks, street trees and plantings, pedestrian-level lighting fixtures, and clearly marked pedestrian crossings.
- The development incorporates or provides access to a network of pedestrian and bicycle paths through green spaces, where appropriate.
- Intersections are designed to facilitate pedestrian crossing.
- Traffic calming elements and the design of local streets encourage slower speeds.
- Parking is permitted on streets.
- Rear alleys provide additional parking and secure access behind commercial and residential structures.
- Structures and amenities within the development are situated to maximize recreational and natural open space.

3. Building Design

Existing Buildings

- Where feasible, existing structures are adaptively reused to preserve and reinforce the traditional fabric of the community.
- Historic buildings and structures are preserved and reused.

Residential Buildings

- Residents can choose from a range of housing types, including single-family homes, townhouses, condominiums, or apartments.
- The development offers homes in a range of price levels.
- Residential buildings are situated in clusters.
- Residential offerings include housing priced to be affordable to low and moderate-income families.
- The development offers high-density residential units.
- Homes provide front porches or balconies to connect residents to sidewalk activities.
- Homes include rear alley garages to reduce their visual impact on the street.
- Residential units are adjacent to or within reasonable walking distance to retail, transit, and/or offices and other civic amenities.
- Residential buildings are oriented and set close to the street.

Commercial/Retail Buildings

- The front facades of commercial buildings use visual elements such as street-level windows, canopies, arcades, overhangs, watercourses, recessed wall planes, or other architectural features to vary the pedestrian-level view.
- Primary building entrances are oriented visually to the street.
- Multi-story commercial buildings include residences or offices on the upper floors.
- Commercial areas provide landscaped public plazas with seating for employees and visitors.
- Parking lots are landscaped, and located away from the street, for example, at the rear of a building.
- Retail and commercial structures are located adjacent to or within walking distance of residential areas.

4. Building Environmental Impact

Special consideration will be given to project submissions which have either achieved U.S. Green Building Council's LEED (Leadership in Energy & Environmental Design) Certification (Certified, Silver, Gold, or Platinum) or which clearly demonstrate effective use of principles of sustainable design

as outlined in USGBC LEED or similar green building rating systems. In addition to site and landscape considerations, use of renewable resources and specific building design strategies could include:

- The building exceeds standard energy performance (ASHRAE/IESNA 90.1-1999) for walls, roof, windows, and HVAC systems and maximizes the use of renewable energy.
- The building incorporates energy-efficient lighting and makes use of diffuse indirect daylight.
- The building provides better than minimum indoor air quality (use of low-VOC building materials), ventilation, thermal, and acoustic comfort.
- New structures are built using environmentally friendly construction materials, such as recycled concrete, certified wood, renewable or salvaged materials.

5. Site and Landscape Design

- The site is landscaped with indigenous and/or water-efficient plants.
- Maintenance of the site's landscaping limits the use of fertilizer and/or pesticides.
- Landscaping minimizes impacts on indigenous vegetation, topography, and other natural systems.
- The development preserves and protects wetlands, meadows, forests, water bodies, and other natural resources and site features, or restores damaged sites or removes environmental contamination.
- New green spaces are created or existing ones are maintained within the development.
- The project incorporates devices to reduce environmental impacts and conserve energy, such as rainwater collection, pervious pavement, wind or solar energy, etc. The site design reduces stormwater runoff and implements on-site use.
- The project uses lighting mechanisms that do not pollute the night sky or negatively affect the surrounding area.

Specific Recommendations:

- Conduct workshops or training sessions with municipal zoning officials emphasizing Smart Growth Principles.
- Conduct workshops or training sessions with municipal zoning officials emphasizing Storm-water Best Managements Practices.
- Conduct workshops or training sessions with municipal zoning officials emphasizing Agricultural Best Management Practices.
- Work with the new owners of the New Morgan Property to incorporate Smart Growth principles into their development designs.

APPENDICES

PENNSYLVANIA FOREST STEWARDSHIP
FOREST MANAGEMENT DEMONSTRATION SITE
At French Creek State Park

Forests cover more than half of Pennsylvania. Most of these are "working" forests, continuously supplying the people of Pennsylvania and people all over the world with essential natural resource amenities and forest products. Because Pennsylvania's extensive forests contain high quality hardwoods, timber harvesting is an important reality and a significant part of our state's economy. Most everyone depends on the forest for wood products, and many people depend on the forest for their livelihood. Others simply enjoy the many forms of recreation and natural beauty the forest provides.

All this "taking" from Pennsylvania's woodlands, particularly timber harvesting, can have a large impact on the sustainability of the forest and its resources. However, with proper planning and careful management, timber harvesting can be beneficial, helping maintain vigorous, healthy, and productive forests. Therefore, it is essential that timber harvesting be employed as part of a professionally prepared management plan that recognizes potential consequences and avoids resulting negative impacts, including erosion and sedimentation, soil compaction, and damage to residual trees.

The forest provides many different benefits, and the preference for how it should be used or not used varies from person to person. For this reason, timber harvesting is frequently a controversial issue. Because most people (forest landowners and the general public) know so little about timber harvesting and its role in maintaining sustainable forests, the controversy is often magnified. To reduce the potential for conflict, we have developed this site to demonstrate alternative methods of timber harvesting along with both their benefits and consequences. With responsible forestry, which may include timber harvesting, we can ensure that biodiversity, wildlife habitat, and aesthetics are maintained.

French Creek State Park is one of nine sites established across the state to demonstrate and study alternative timber harvesting practices. The major objective of this project is to encourage responsible forest resource management. We want all visitors to embrace this forest stewardship ethic. Because French Creek State Park draws many visitors, this site provides us access to a large number of people who care deeply about forests and who want to form educated opinions about natural resource management.

In order to facilitate understanding of the project, the treatments, and the considerations involved, we offer the following definitions of some of the terms frequently used in forestry:

- Forestry: the art and science of establishing and managing forests and their associated resources for a variety of benefits and values.

- Regeneration: the replacement of one forest stand by another as a result of natural seeding, sprouting, planting, or other methods.

- Residual stand: trees that remain following any cutting operation.

- Silviculture: the art, science, and practice of establishing, tending, and reproducing forest stands with desired characteristics. Cutting is the primary tool of silviculture and can either promote growth of desirable species or the establishment of new trees.

- Stand: a grouping of forest vegetation sufficiently uniform in species composition, age, and condition to be distinguished from surrounding vegetation types and managed as a single unit.

- Stewardship: the wise management and use of forest resources to ensure their health and productivity today with regard for generations to come.

The Treatments

Six treatments, two acres each, are demonstrated along Fire Tower Road. There are three on each side of the Red Trail. The treatments include various types of thinning and regeneration harvests.

NO HARVEST

The major objective of this project is to encourage the wise management of forests by showing the results of alternative timber harvesting treatments. However, our demonstration would be incomplete without first permitting you to see how the forest would appear without a treatment. In many circumstances no cutting may be a preferred alternative. Please keep in mind though, that forests, even without cutting, are dynamic, and ever-changing.

Block 1. Control. For comparison, nothing is removed from this plot.

THINNINGS

Tree mortality (death) is a natural, ongoing process in the forest. Young forests with small trees support many thousands of individual trees per acre. As the forest matures and individual trees become larger, many of those thousands of trees are crowded (by faster growing neighbors) and die. The trees in this forest began to grow around the turn of the century, and there were nearly 500 per acre before treatments were applied.

Thinning is a forestry technique used to "capture" some of the potential mortality by harvesting selected trees. Thinning reduces crowding and, by redistributing the growth potential to the most desirable trees on the site, the overall health, vigor, and growth of the remaining stand is increased. Those "residuals" or remaining trees may have been selected for one of many reasons, including wildlife habitat (a "cavity" tree), timber, or aesthetics. Thinning also provides some intermediate return on a landowner's long-term forest investment. Three of the treatments along Fire Tower Road are thinnings. These sites were fully stocked before harvesting. That is, there were no openings in the forest. Viewed from above, the crowns or branches of the trees seemed to touch one another in a continuous, green carpet. There was no room for individual crowns to grow and expand. The purpose of our thinning treatments was to reduce the stocking or density to 60 percent to give the residual trees additional room to reach out, thus increasing their rate of growth.

Block 2. Diameter-Limit from Below. A diameter-based thinning-from-below reduces the stocking (to 60 percent) by removing all trees smaller than a calculated diameter. Because the decisions about which individuals to remove are driven by diameter alone, there is no opportunity to deliberately allocate growing space to meet objectives. For instance, if all the trees on the site are of approximately the same age, a common condition in Pennsylvania, the smaller ones are growing slowly and competing poorly with their larger neighbors. Removing them typically provides little additional growing space to the larger ones. Also, by removing all the trees of similar size, we may actually eliminate one or more tree species that happen to grow and develop naturally at a slower rate. Although the resulting forest can look almost park-like, which is pleasing to many people, the treatment can have important negative effects. Small trees and shrubs provide food, homes and hiding places for wildlife, and their removal may significantly reduce wildlife use of the area. Also, a diameter-based cut from below will likely not be an economically viable option, in terms of both immediate cash flow and ultimate financial return.

Block 3. Improvement Thinning. An improvement thinning represents the professional forester-recommended silvicultural treatment for this forest stand. It was designed to meet a set of specified objectives, including production of timber for income, maintenance of wildlife habitat, and protection of the soils and related resources. In an improvement thinning, the resource professional balances the landowner's management objectives with forest conditions, the site and markets, and then selects individual trees to cut or to leave on the basis of species, spacing, and tree quality .The result is that trees of many sizes are removed and growth is redistributed by making growing space available to desired trees. In this way, the overall quality of the forest is improved for whatever objectives were chosen. Typically, the immediate cash return from this type of thinning does little more than cover its costs, but the treatment serves as an investment in the future of that particular forest.

Block 4. Diameter-Limit from Above. A diameter-based thinning-from-above reduces the stocking (again, to 60 percent in this case) by removing all trees larger than a calculated diameter. Those largest trees are selected on the basis of diameter alone, regardless of

their location with respect to other trees. Neither of the diameter-based thinnings shown in this demonstration is rooted in sound forestry. The results are generally undesirable. Once again, when all similarly sized trees are removed, certain tree species can be completely eliminated from the remaining stand, and in an even-aged stand (most in Pennsylvania are), the burden of ultimately regenerating the forest falls on the smaller and possibly genetically inferior residual trees. Because the remaining trees are not younger, but instead are slower growing, damaged, diseased or less vigorous species, they may not be able to respond to the increased growing space made available to them by the thinning. This is a negative impact on long-term forest health and diversity. In addition, this treatment allows no consideration for wildlife habitat A diameter-based cut from above probably yields the highest immediate cash return of any thinning, but the long-term financial yield is drastically reduced. The residual stand, dominated by low value and poor quality trees, is simply unable to generate much future income potential.

REGENERATION HARVESTS

Forests are a renewable natural resource. Forests left completely undisturbed do not live forever. Once a tree becomes "mature," growth slows, resistance to insects and disease is reduced, and its ability to respond to injuries diminishes. Old trees are eventually harvested naturally, dying and then crumbling or crashing to the forest floor to donate their nutrients to the soil where they can be used by other living organisms and new seedlings. In a regeneration harvest we are mimicking this slow natural process to ensure long-term forest sustainability. Old trees are removed as efficiently as possible in order to supply the space and access to resources (light, moisture and nutrients) needed for the establishment of a new crop. When making decisions regarding a regeneration harvest one must consider the characteristics of the site, including soil and topography, the species of trees in the forest and their specific regeneration requirements, as well as possible impacts on wildlife and water resources.

Block 5. Clearcut. A clearcut, as defined by foresters, removes all the trees in one cutting, mimicking a natural disturbance like a fire or windthrow. In our hardwood forests, care must be exercised to make sure that naturally occurring regeneration is adequate before the cut is made. Otherwise, establishment of the new forest can be delayed significantly, and the site may become occupied by grasses and ferns or trees that do not meet the landowner's objectives. When applied appropriately, this treatment will lead to a forest of similarly aged trees, the most abundant being those that grow best in high levels of sunlight. The financial returns associated with this treatment can be high, but the aesthetic value of the forest for most observers is diminished until the new forest becomes established. Although the term "clearcut" imparts a very negative image to most people, harvesting a mature forest may be a good option for a landowner, depending upon the growth patterns of involved species, the timber market, and the conditions of the site.

Block 6. Shelterwood. A shelterwood cut removes both small trees and some large trees, the exact treatment varying from site to site. This regeneration treatment, which is less visually disruptive than the clearcut, favors tree species that require less than full sunlight to regenerate or trees that grow best under the shade or

shelter of other trees. In addition to their sheltering function, the trees left after the first cut serve as seed sources for the new forest. Therefore, a shelterwood cut has the added benefit of allowing new tree seedlings to become established over time, reducing the risk of having no new growth. The first cut of the shelterwood treatment offers only limited initial cash flow. Much higher returns are realized when the new stand is established and the larger, residual trees are removed. This treatment will be re-evaluated in10 years and if sufficient regeneration is present it will be harvested, if not, a second cut may be applied to stimulate additional regeneration establishment and growth.

The Impact of White-tailed Deer

At French Creek State Park, deer are expected to have a large impact on the growth of new seedlings and other vegetation. To examine this factor, we have erected a 20-foot X 20 foot deer exclosure within each treatment area. The areas inside the fences will be compared with adjacent areas outside the fences to evaluate differences in plant species abundance and composition.

* * *

Each research plot will be measured three years and 10 years after harvesting. We will monitor factors related to plant and animal species diversity, residual and new growth, mortality, and economic value of each treatment. Additional harvests may be conducted in the future to maintain density at 60 percent within the thinned treatment areas.

As we've pointed out, the timber harvesting alternatives presented do not all represent good forestry, but regardless, they are all used in Pennsylvania. The diameter-based thin-from-above treatment, also called "high-grading" because it removes the best or highest grade trees and leaves the rest, is particularly common on private, individual properties in the state. The purpose of this demonstration is to provide landowners, timber harvesters, foresters, and concerned citizens with some harvesting options, displaying both their positive and negative consequences. In addition, we hope to make you aware of some of the many considerations that should be a part of harvesting decisions. After all, our actions today have a great deal of bearing on the future sustainability of Pennsylvania's forests.

As a result, we hope that forest landowners who visit the site will use the knowledge gained and, with the help of professional forest managers, incorporate their own objectives into a forest management plan. We believe all visitors can learn enough about responsible forest management to help form educated opinions about important forestry issues. Finally, we encourage you to embrace the forest stewardship ethic and share the spirit of responsibility for our renewable natural resources.

Please remember that all of us use, in fact depend on, forest products. Timber harvesting is an essential practice that can serve as an effective, environmentally sensitive tool of forest management. Join us in encouraging responsible management of all forests, public and private.

PENNSYLVANIA FOREST STEWARDSHIP – FRENCH CREEK STATE PARK
FOREST MANAGEMENT DEMONSTRATION SITES

1. 100 year old clearcut. Wood was cut for Hopewell Furnace.

2. Deer exclosure. Not much of a difference because deer population was low in area at time of cut.

3. Improvement Cut. Increased the average stand diameter. Trees of all sizes were cut.

4. Thinning from below. Everything smaller than 12 inches in diameter was cut. This is a park-like setting. Not very much cover for wildlife.

5. Control. Nothing was done here.

6. The trail shows compaction. Nothing is growing.

7. This was the log landing for the clearcut. It was limed, fertilized, and seeded with grass. (1994)

8. Clearcut. Notice all of the small trees growing. It is very thick and provides excellent cover for wildlife. This is in the early stages of succession. Look at all of the stump sprouts from the areas where the trees were cut. Eventually they will compete for light and nutrients and only two stems will be left out of the whole clump.

9. Shelterwood cut. The trees were left to provide shade and shelter to the new seedlings. The trees that were left should be removed in about 10 years after initial cut. The stand would have to be re-evaluated.

10. Thin from above. This is also called a diameter limit cut or high grade. All trees over certain diameters were cut, leaving small, grubby, lower quality trees for the future. This is an example of a poor forestry practice. The trees are low value that you see.

11. This is an old charcoal flat from the early 1900's.

12. This shows a sign of change. Forests are constantly changing. There are a few small American Chestnut trees growing in this area. The Chestnut Blight wiped out all of the big chestnut trees years ago, changing Pennsylvania's forests forever. The wind damage also shows how nature opens up the tree canopy to allow sunlight to reach

the ground. The wind is nature’s way of cutting trees down.

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Carr's Recreation Park: www.fieldtrip.com/pa/amuse-pa

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Hay Creek Watershed Association: www.haycreekwatershed.org

Highlands Coalition: www.highlandscoalition.org

Millersville University Earth Science/Geology/Earthquakes:
www.muweb.Millersville.edu/~esci/geo/quake

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Natural Lands Trust: *www.natlands.org*

National Register of Historic Places*: www.cr.nps.gov/nr*

Natural Resource Conservation Service: www.nrcs.usda

Nature Conservancy: www.nature.org

Pennsylvania Audubon Society*: www.audubon.org/chapter/pa/IbaFactSheet*

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www.pabulletin.com/secure/data/vol31/31-13/575

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PA Department of Environmental Protection: *www.dep.pa.us*

Penn State Cooperative Extension: www.extension.psu.edu

Pennsylvania State Data Access: *www.pasda.psu.edu/*

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Schuylkill River Greenway Association: www.schuylkillriver.org

Schuylkill River Watershed Conservation Plan: *www.schuylkillplam.org*

10000 Friends: www.10000friends.org

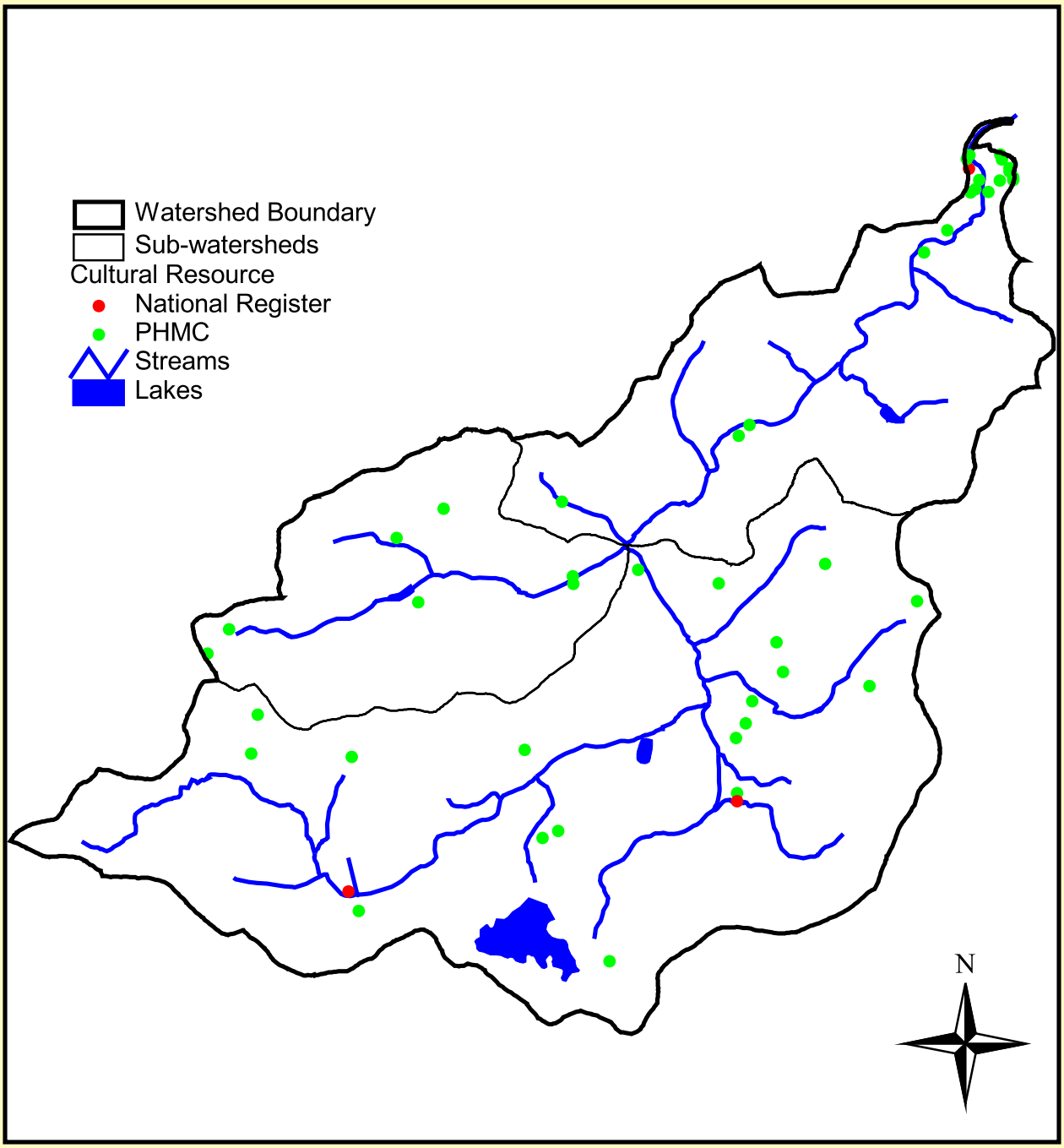
U. S. Department of Agriculture: www.usda.gov

U. S. Fish and Wildlife Service: www.fws.gov

U. S. Geologic Survey: *www.usgs.gov*

Well Head Protection:
www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/srceProt/final_WHPP

Hay Creek Watershed
Cultural Resources



1 0 1 2 3 4 5 Miles

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Figure # 18

Hay Creek Watershed
Dams and Impoundments

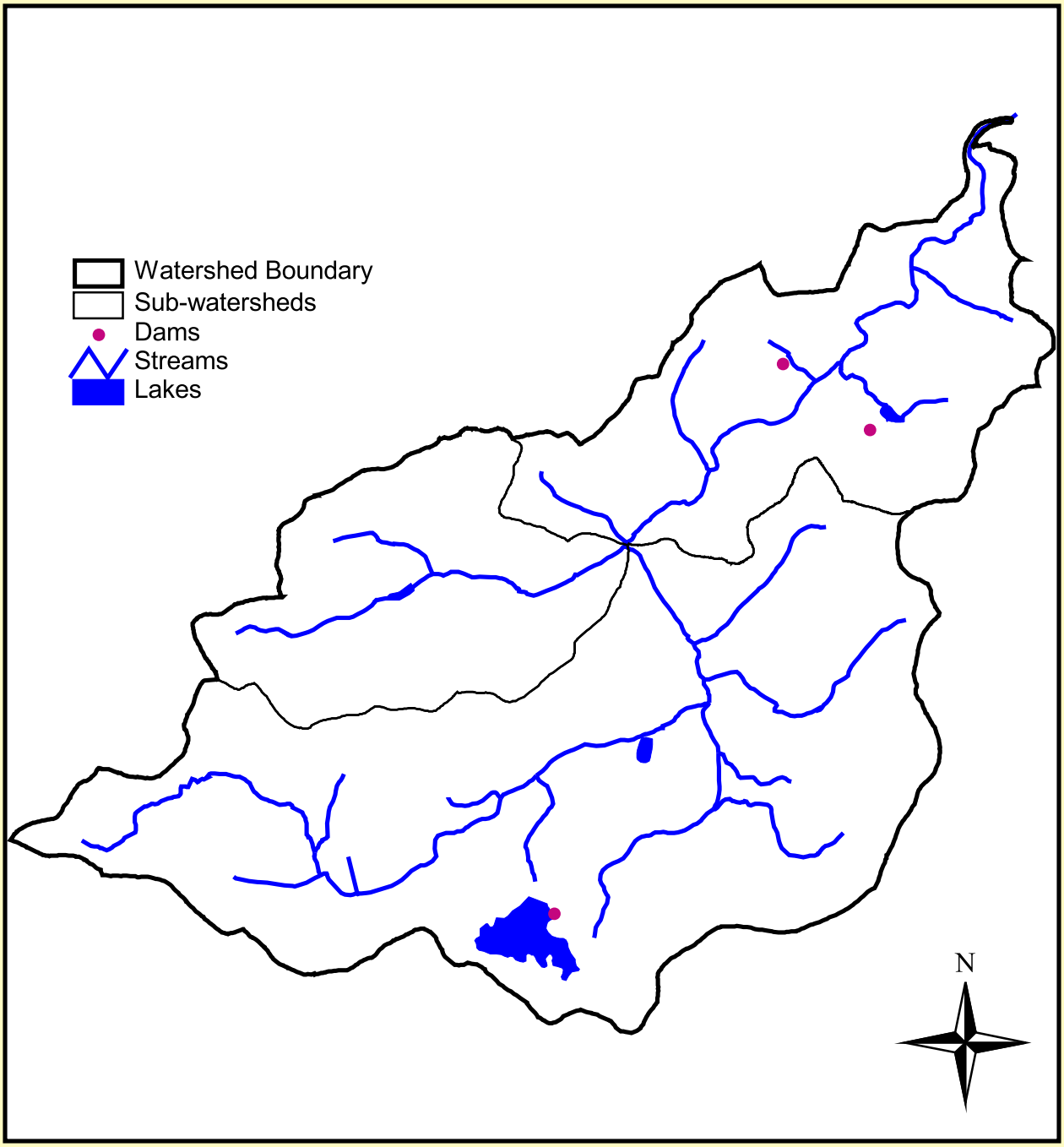

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Figure # 15

Hay Creek Watershed Conservation Easements

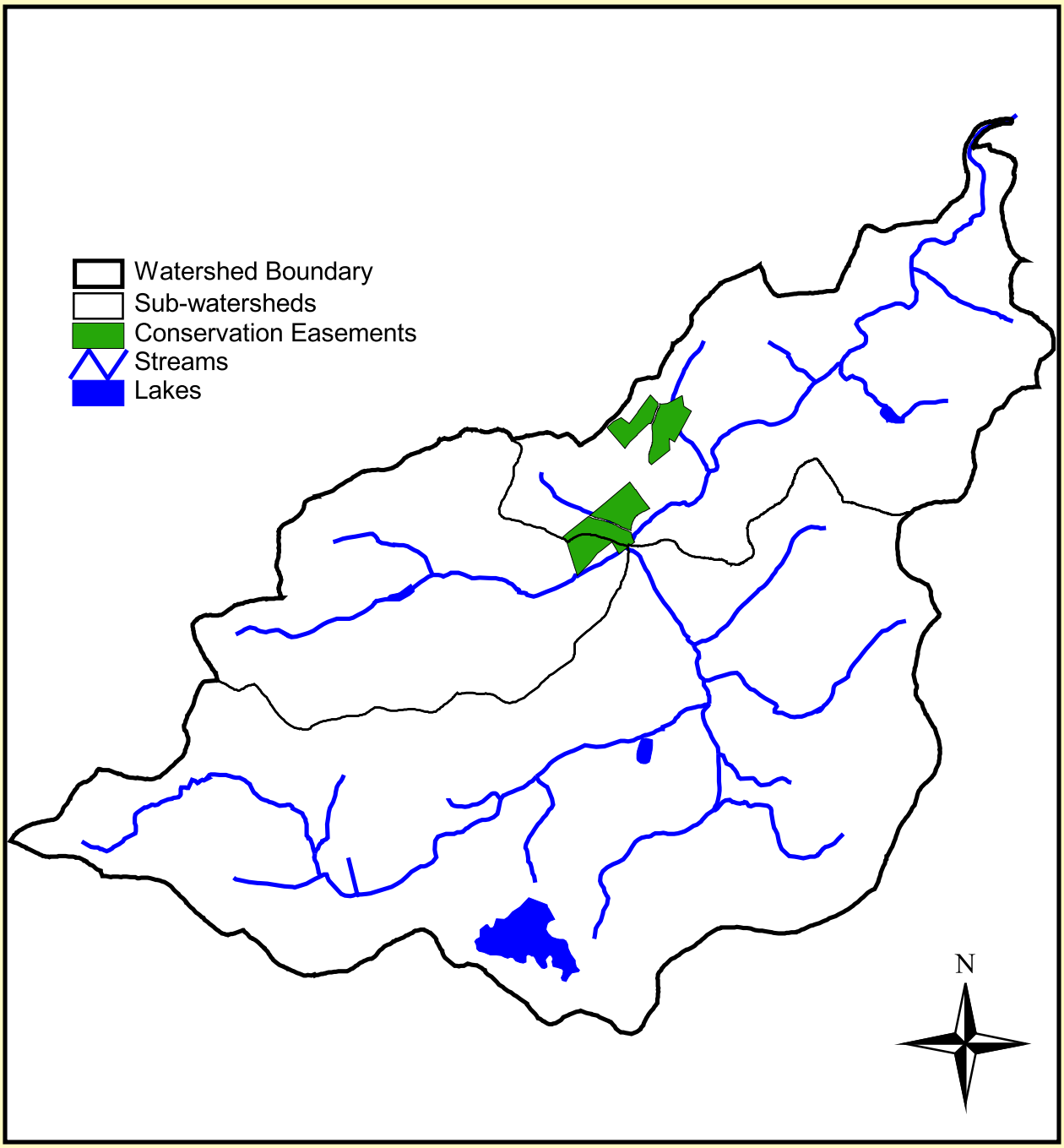

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Figure # 14

Hay Creek Watershed
Housing Units

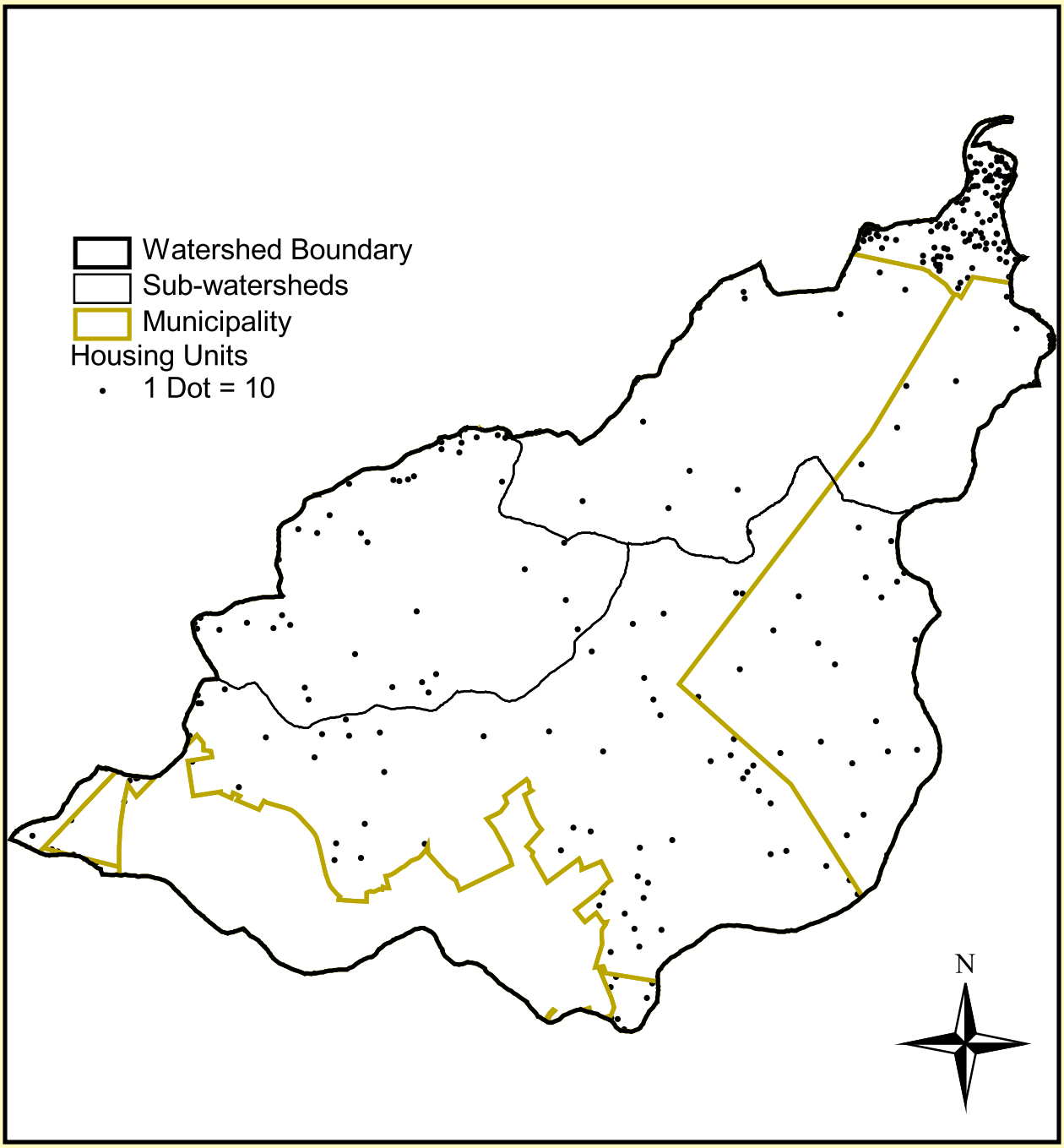

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Figure # 7

Hay Creek Watershed
Hydric, Floodplains, Wetlands

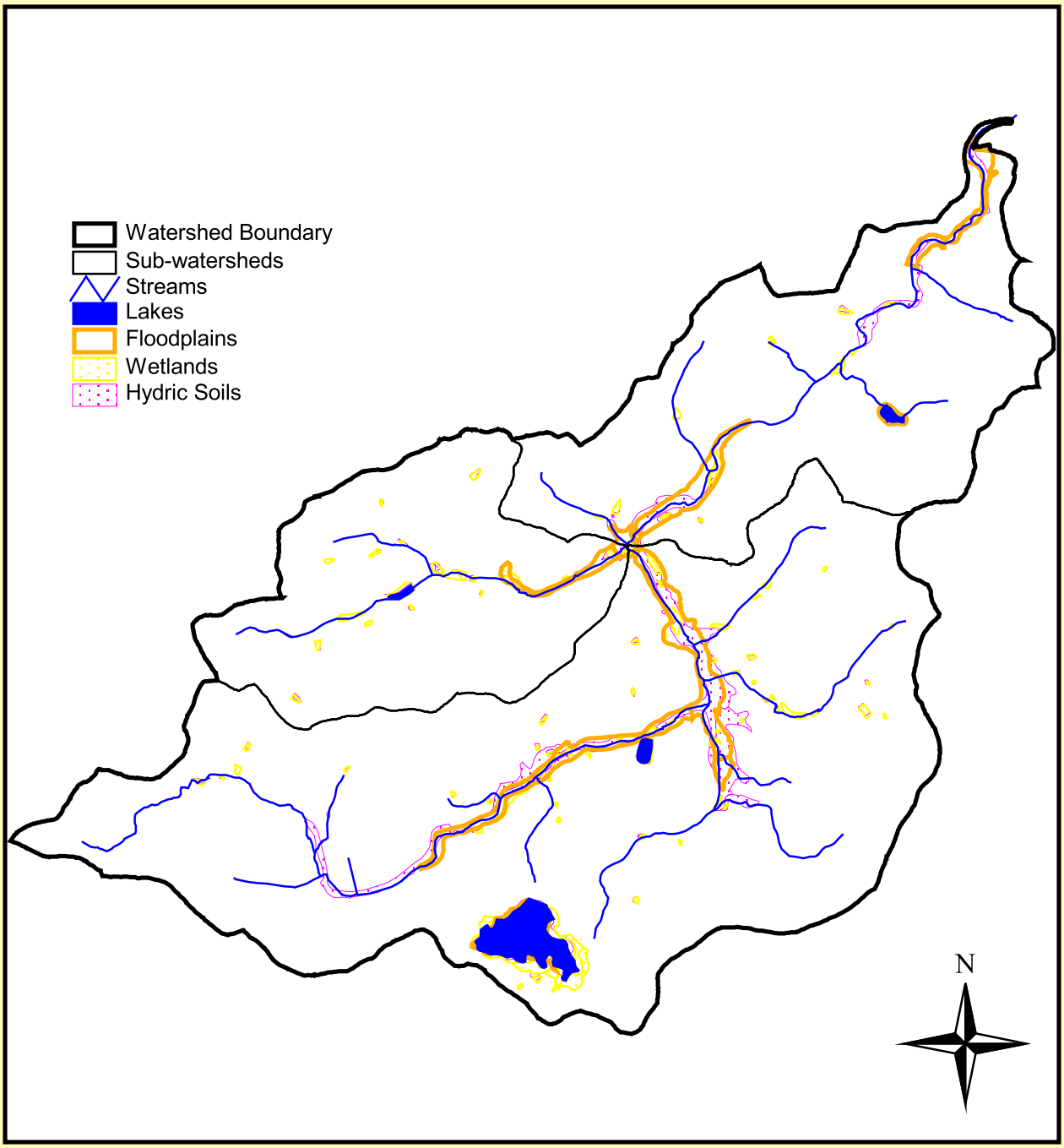

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Figure # 16

Hay Creek Land Cover

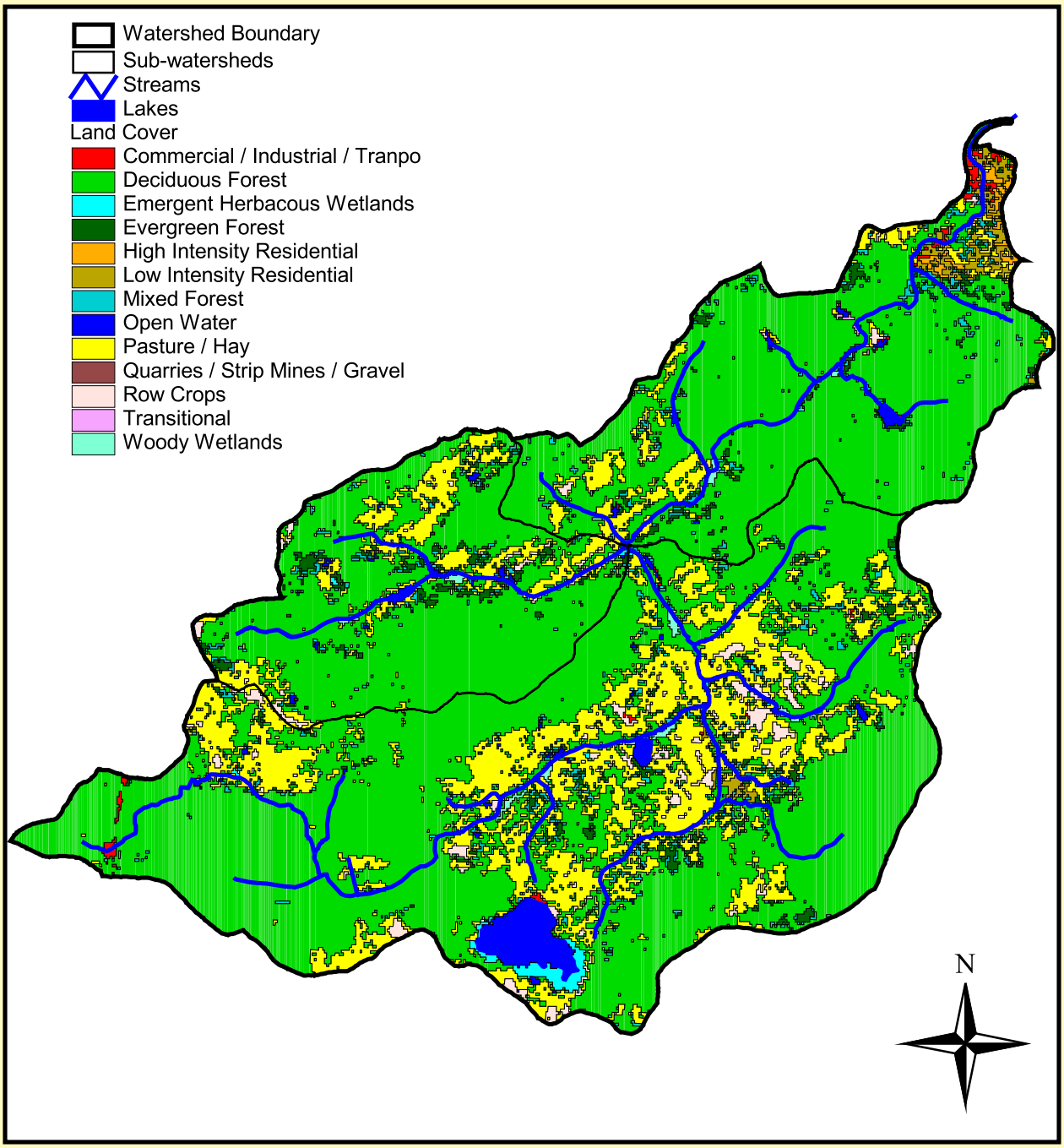

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Figure # 9

Hay Creek Watershed Location

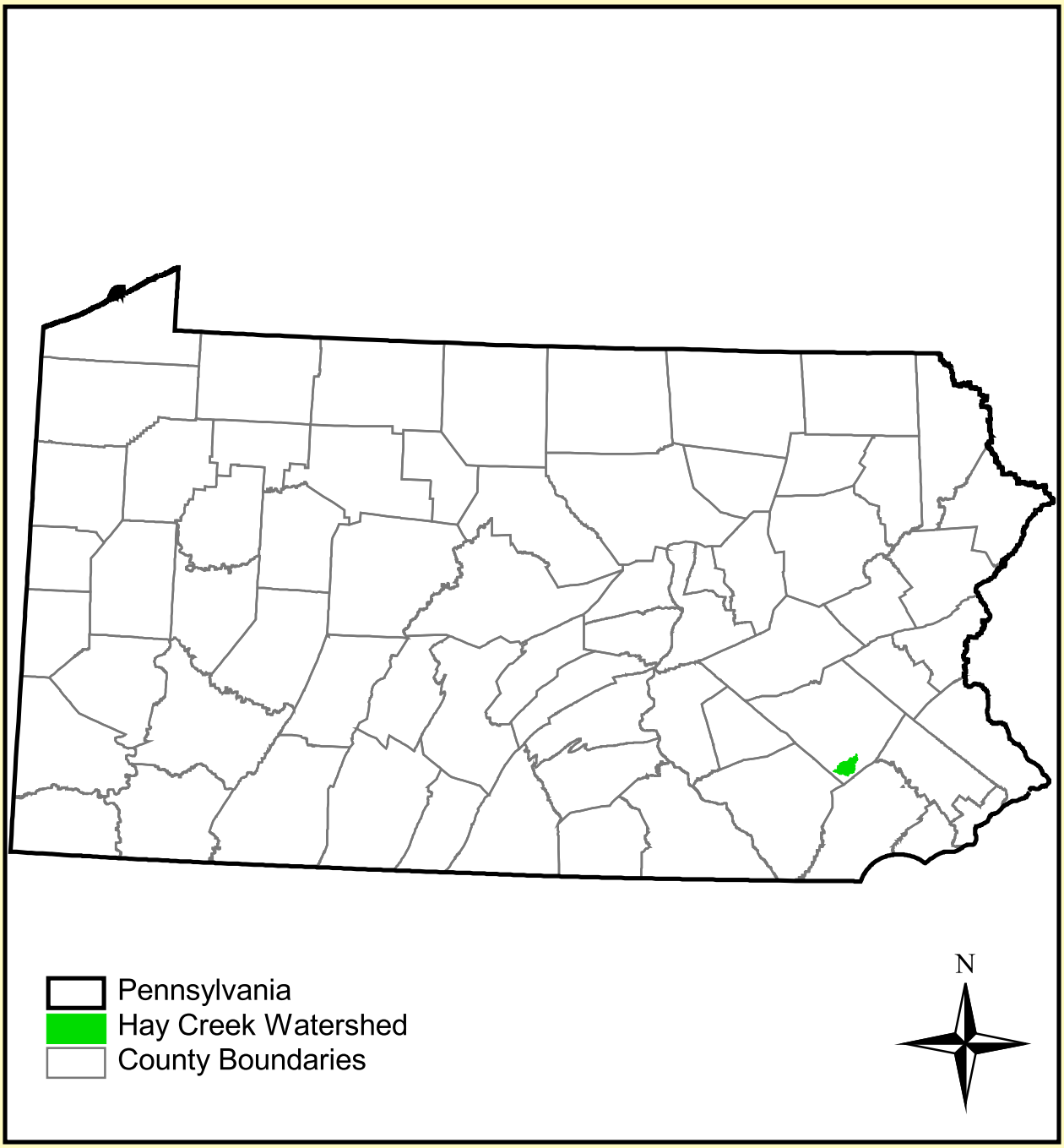

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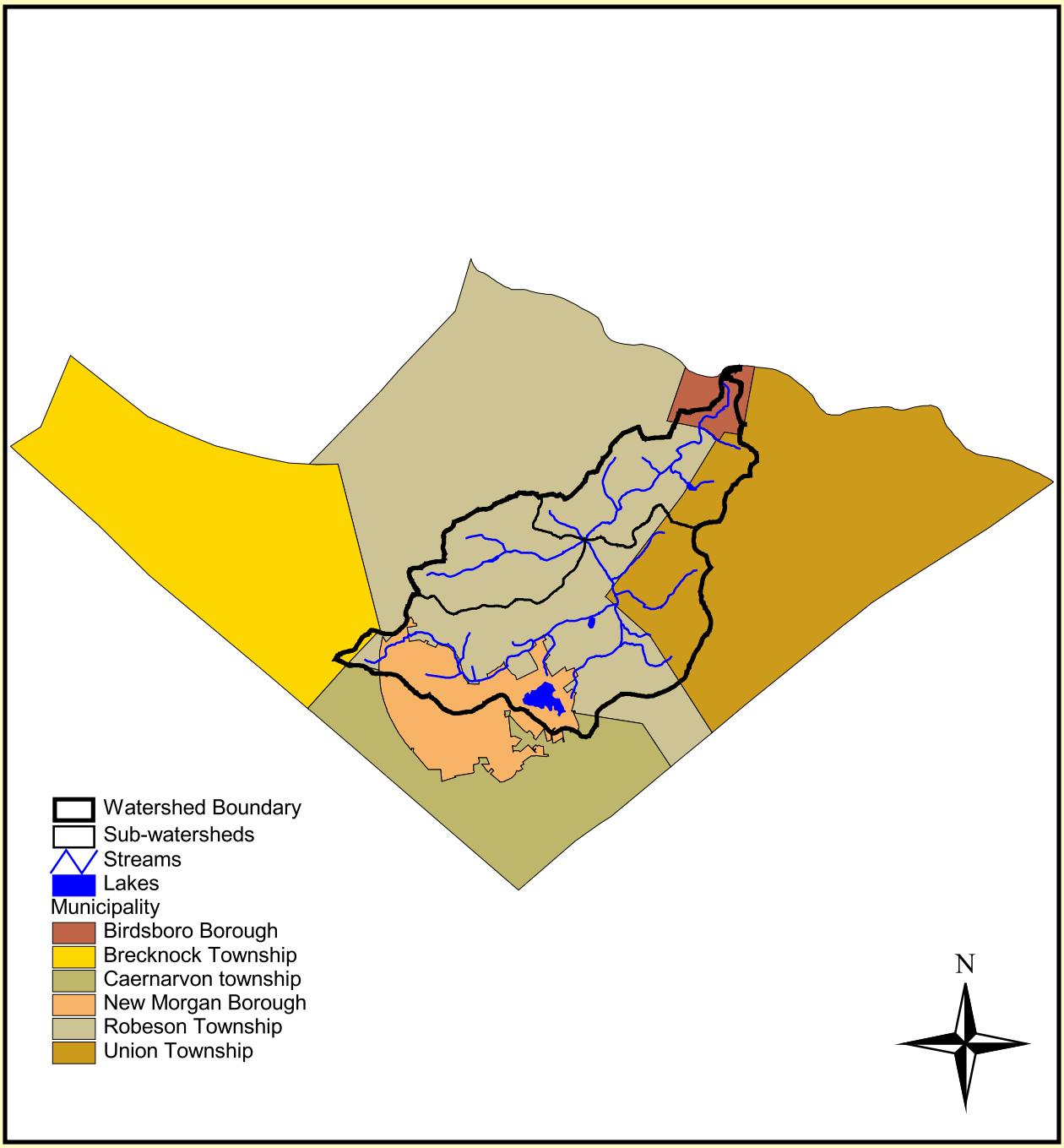
Figure # 1

Hay Creek Watershed Municipalities



2 0 2 4 6 8 10 Miles

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Figure # 2

Hay Creek Watershed
Natural Areas Inventory

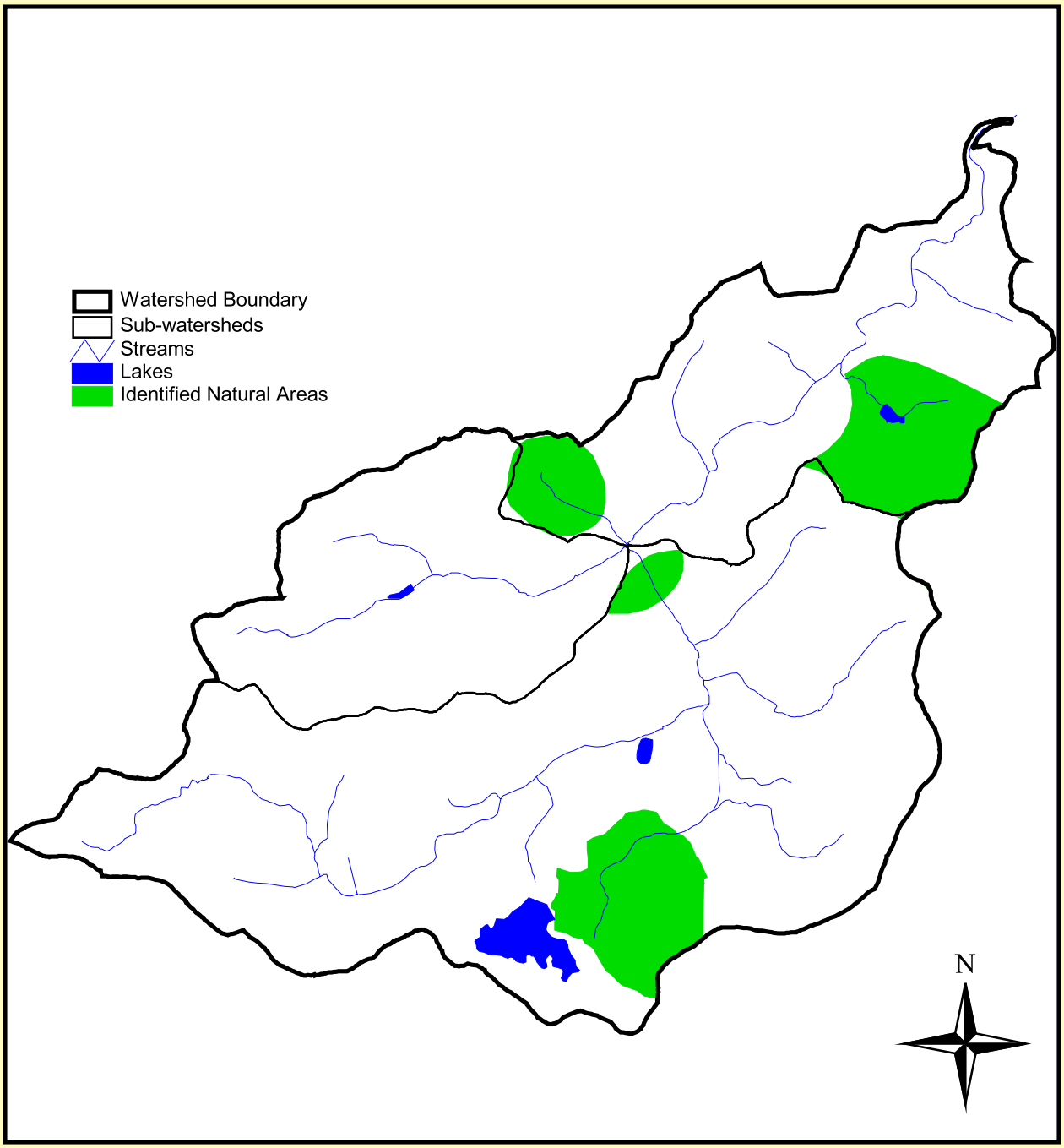

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Figure # 17

Hay Creek Watershed
Physiographic Provinces

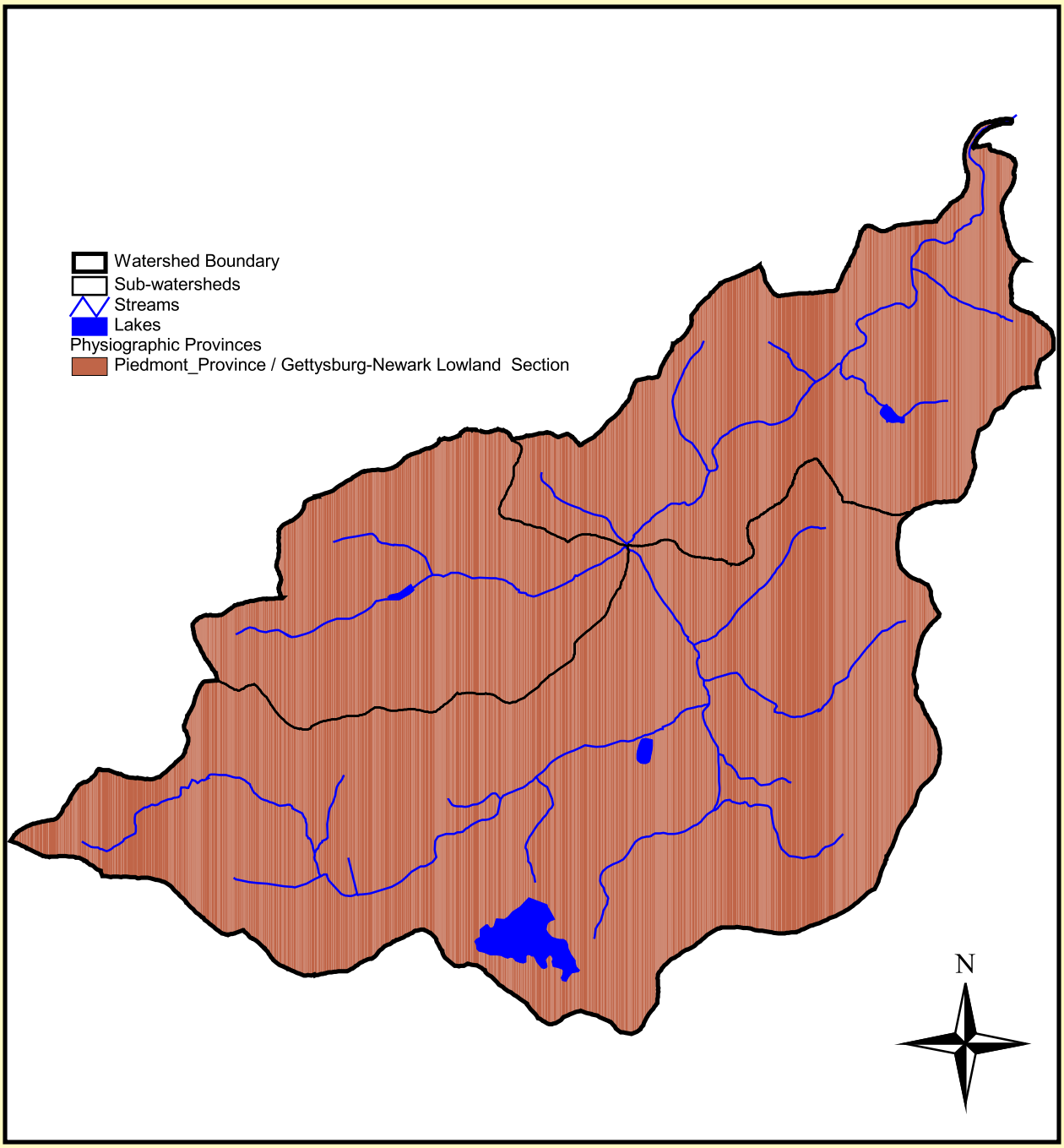

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Figure # 3

Hay Creek Watershed Population Distribution

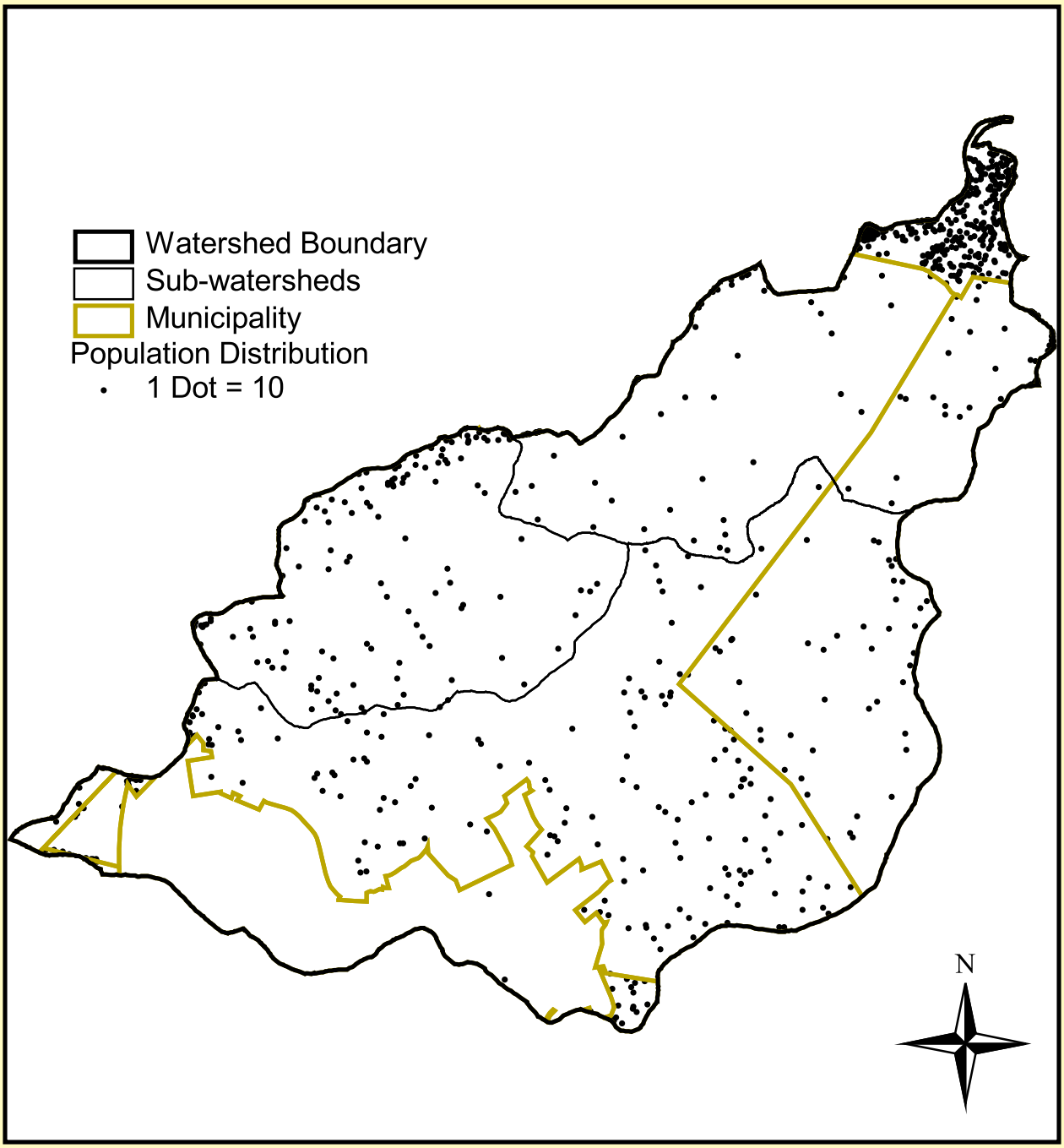

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Figure # 6

Hay Creek Watershed
Prime Agricultural Lands

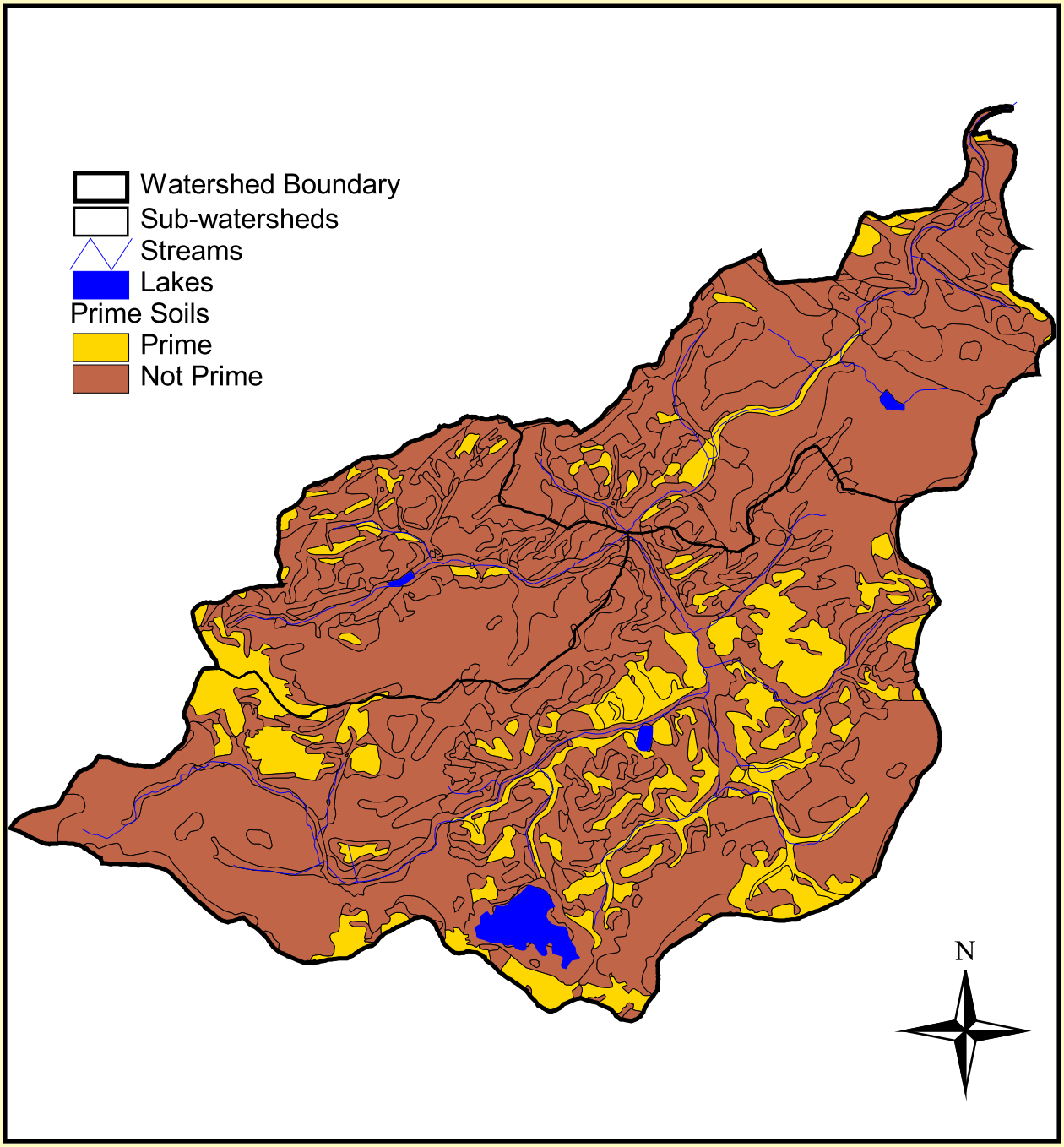

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Figure # 11

Hay Creek Watershed
Protected Uses

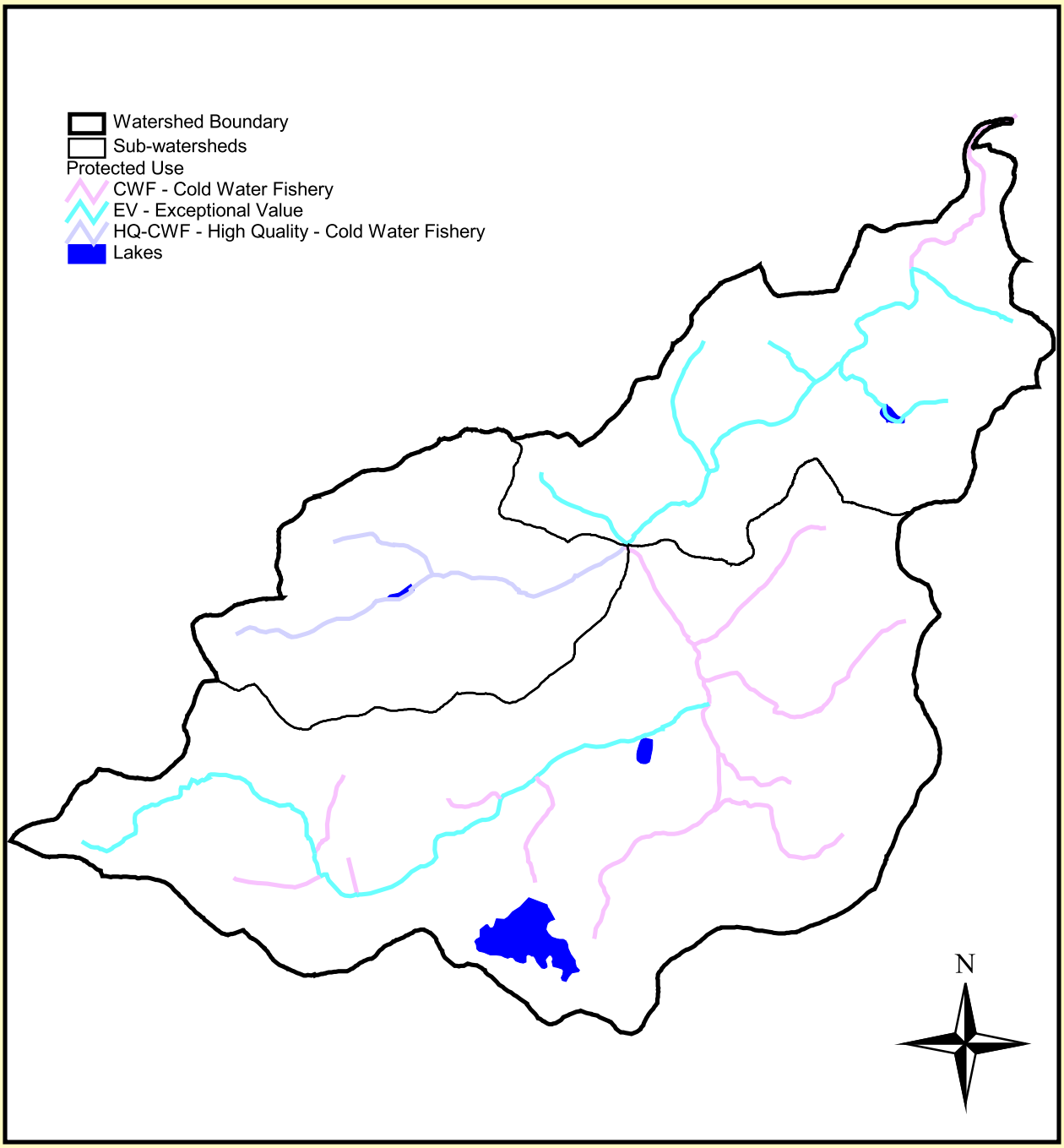

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Figure # 5

Hay Creek Watershed
Public Uses

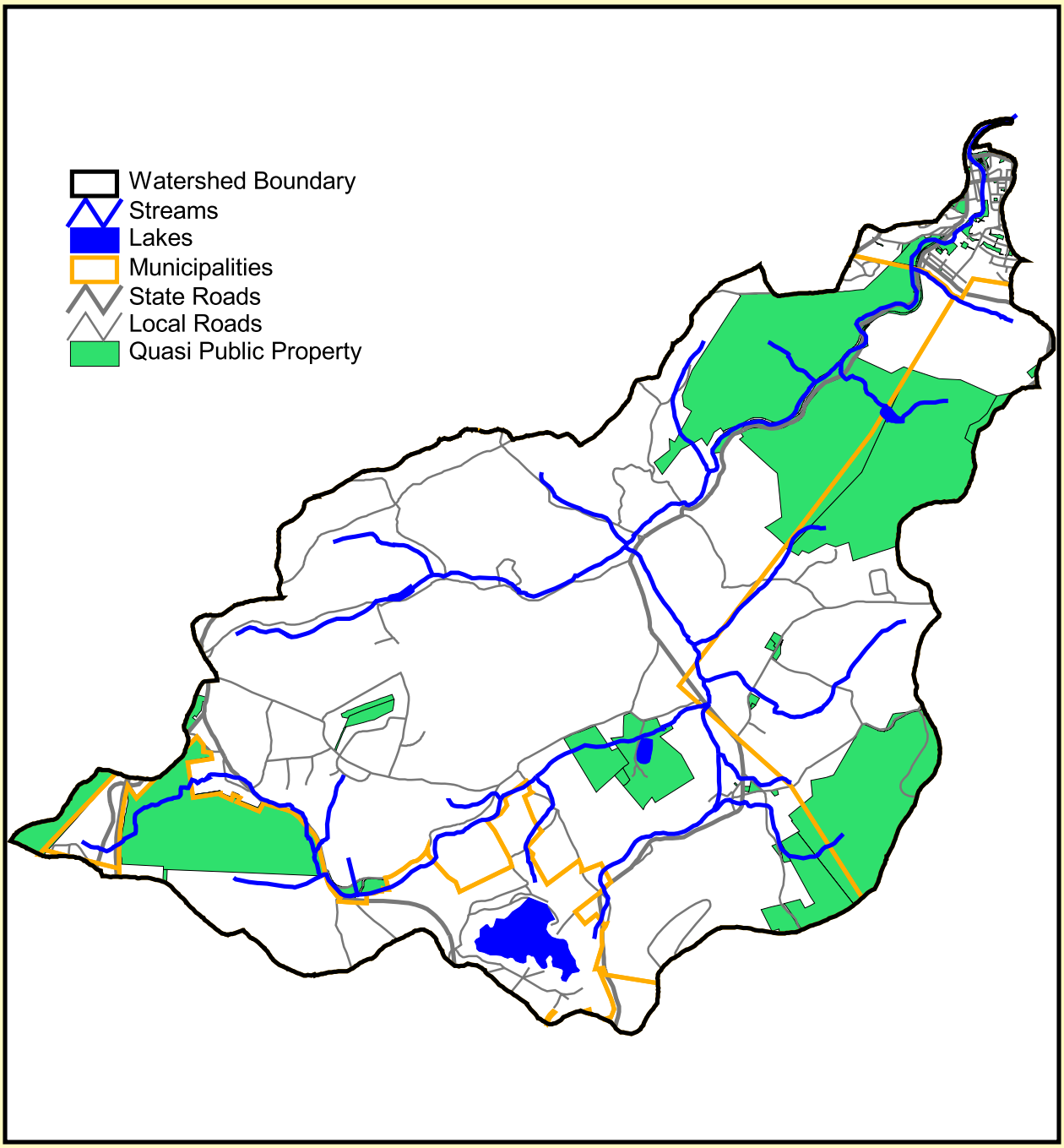

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Figure # 13

Hay Creek Watershed
Soil Capability Class

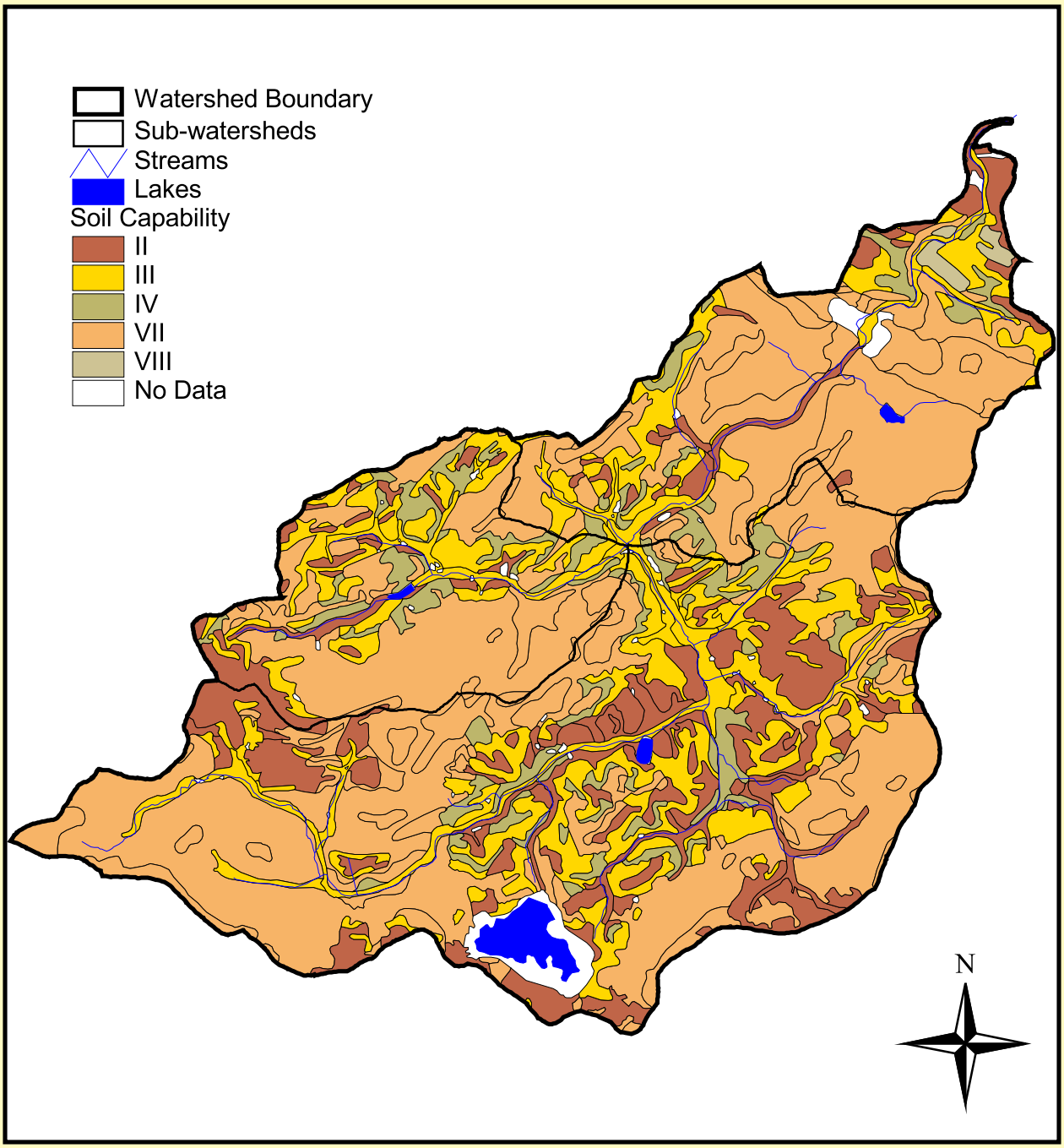

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Figure # 12

Hay Creek Subwatersheds

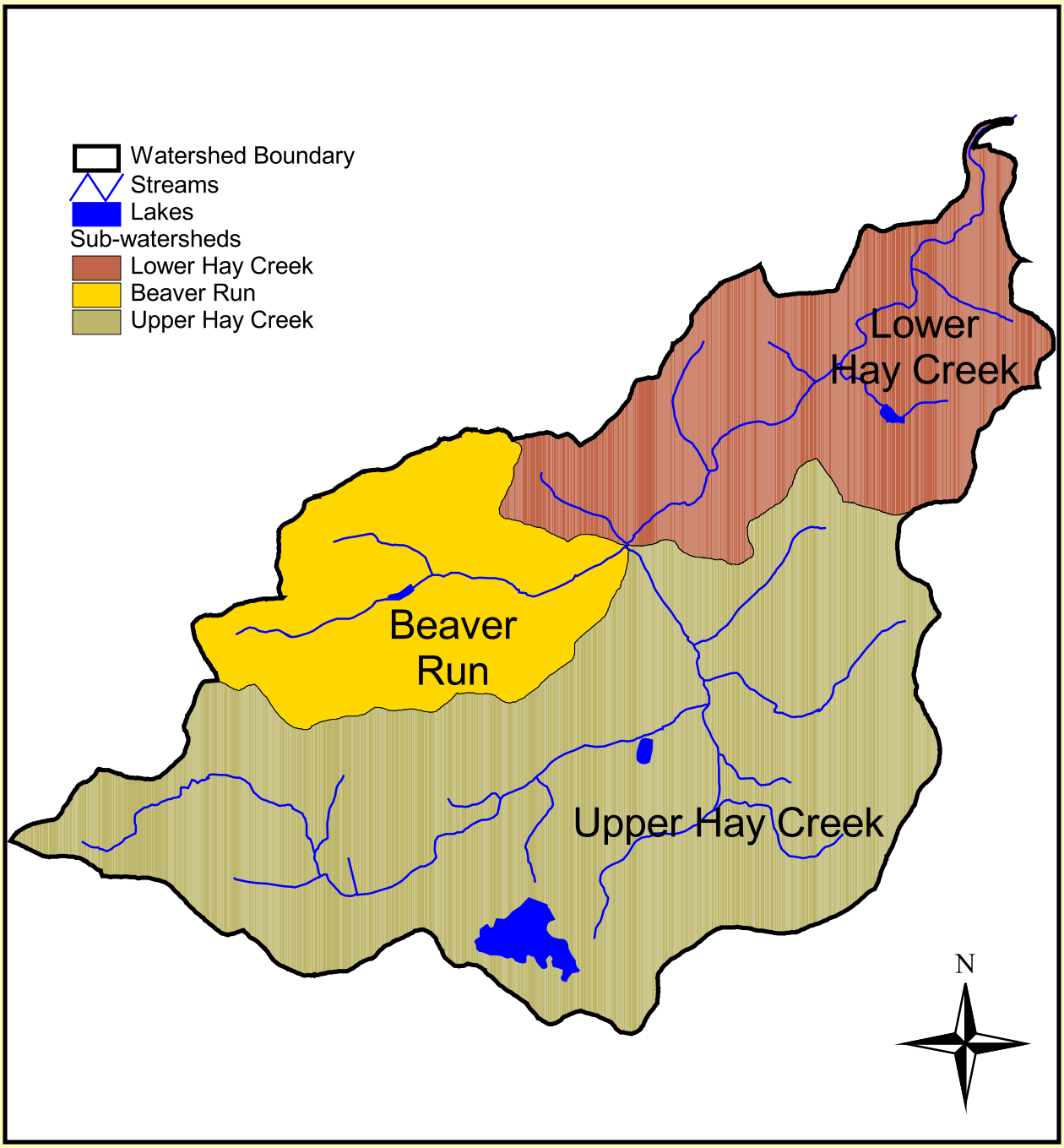

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Figure # 4

Hay Creek Watershed
Surface Geology

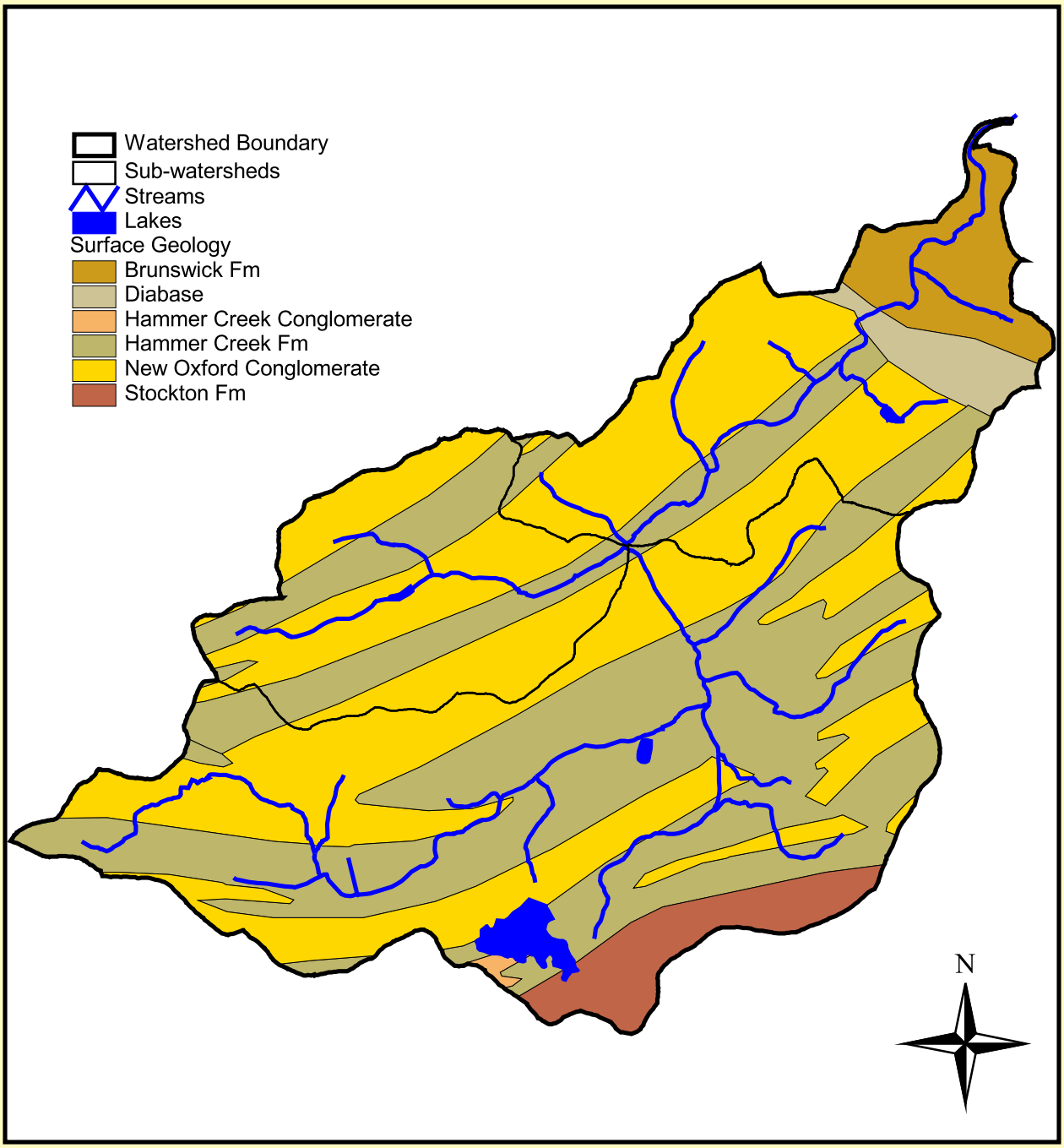

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Figure # 10

Hay Creek Watershed
State & Local Roads

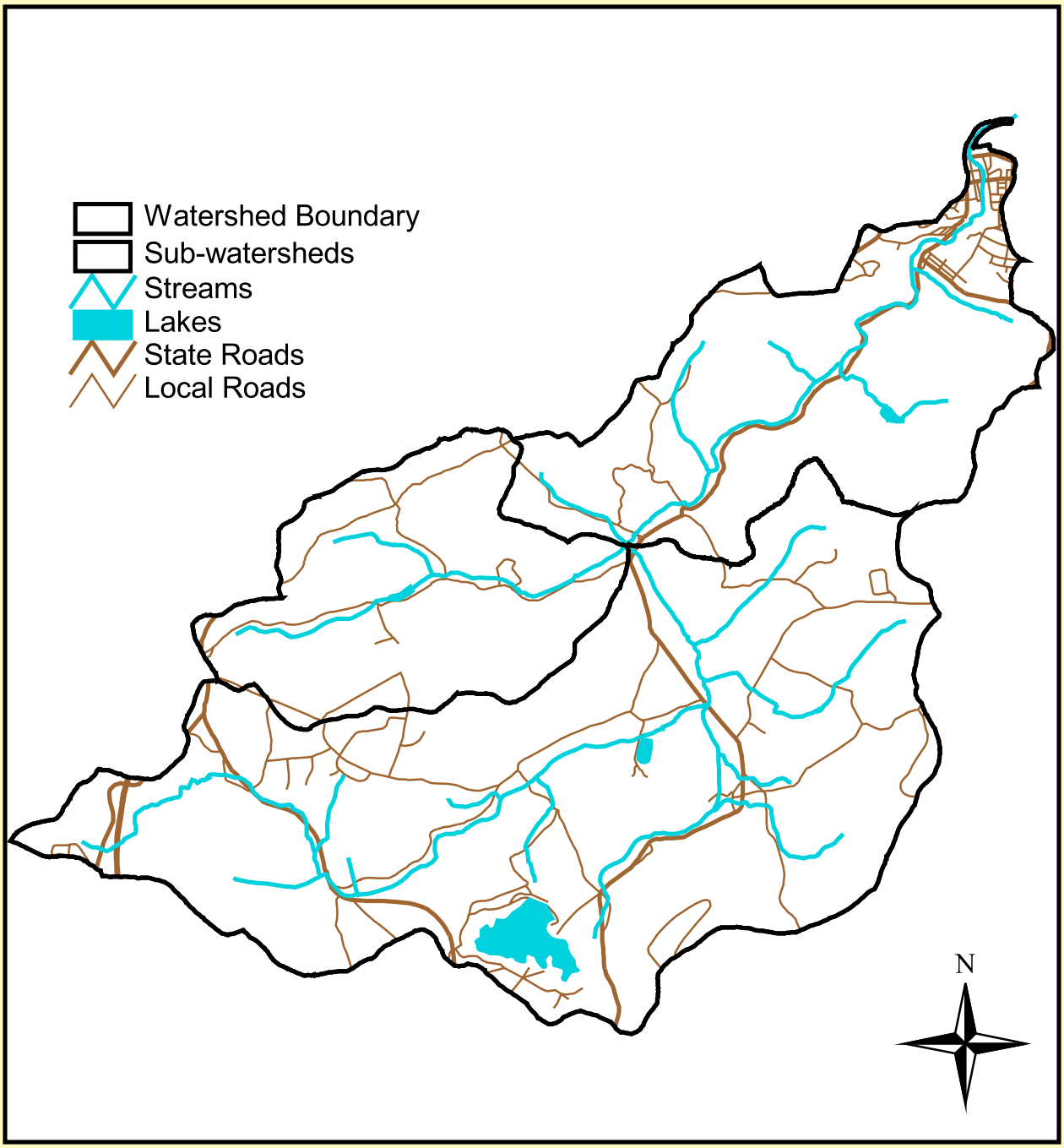

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Figure # 8