Big Spring Watershed
River Conservation Plan

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Acknowledgments

The completion of this plan is dedicated to Norm Shires (1928 – 2005), for his life-long commitment to preserving environmental quality and trout-fishing heritage on Big Spring and other "limestone legends" of Pennsylvania.

"*Why does Big Spring warrant this dissertation? …….. to protect a priceless natural resource, the limestone streams of south-central Pennsylvania. If Big Spring is not one of these, none other is.*" *Norm Shires. 1997. Postscript in "Limestone Legends" Papers and Recollections of the Fly Fishers' Club of Harrisburg 1947-1997. Compiled by Norm Shires and Jim Guilford. Stackpole Books.*

The late Kurt Schneider was also instrumental in early stages of the plan, as well as in securing matching funds from the Alexander Stewart Foundation of Shippensburg, PA for delineating contributing areas of Big Spring.

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EXECUTIVE SUMMARY

Big Spring Watershed Association (BSWA) formed in 2001 with the goals of protecting and managing wild native trout populations of Big Spring, and the other natural, cultural, and historical resources of the watershed. This plan reviews these resources in detail, relying on a broad array of partners and public input, in order to provide best possible information to policy makers and to prioritize project opportunities for meeting these goals. These priorities are provided in the management matrix (Appendix 6). The plan was prepared with a matching grant to BSWA to begin delineation of contributing areas through hydrogeological study. Administrative assistance was provided by Pennsylvania Environmental Council staff, other critical input was provided by a steering committee and others as noted above, and the plan was authored by BSWA board members.

Big Spring and its topographical surface watershed are located in Cumberland County, Pennsylvania twelve miles west of Carlisle, PA (Appendix 1 Map 1). The stream and surrounding region are characterized by karst, or limestone topography, where groundwater flow occurs preferentially through limestone fractures, conduits, and caves. This flow often occurs between surface watershed divides. Hydrological tracers in an accompanying study indicated linear flow patterns down-valley to Big Spring, from far outside the surface watershed). While most of this plan will address the surface watershed, the area encompassing the documented regional flow needs immediate attention. Dye trace results proved direct hydrologic connection between runoff from impervious surface to Big Spring, via a sinkhole in a failed stormwater detention basin near the Burd Run/Middle Spring surface watershed 5.5 miles to the west.

Present impacts to Big Spring within the stream corridor include legacy sediment, farm fragmentation and development, stormwater runoff, sewage treatment plant effluent, past mining activity that still introduces sediment, and impervious surface of the state fish hatchery that carries runoff directly into the headwaters. Most impairment of the once renowned native brook trout fishery and the supporting aquatic community was very likely caused by fish culture at a private hatchery in the mid-1900s and at the state hatchery at the stream's source between 1972 and 2001. Wild trout populations persisted above the private hatchery and are now recovering below the closed state hatchery. Other influences may have included sedimentation from mining and agriculture in the early 1900s, although brook trout persisted in apparently high densities during this time.

The largest population center in the watershed area, both historic and present day, is the Borough of Newville. Two other minor centers of population are Springfield and Stoughstown. All three towns share a rich cultural and industrial history beginning with white settlement around 1735. Partnering with the Cumberland County Redevelopment Authority, the Newville Borough Council has taken advantage of the town's proximity to outdoor attractions that include not only the Big Spring Creek but the Colonel Denning and Pine Grove Furnace State Parks. The development of ecology and heritage tourism became the cornerstone of Newville's Town Center 21 Plan. The first step in the realization of this concept was the building of a trailhead center and parking lot at the Cumberland Valley Rails to Trails juncture with Newville. The Cumberland Valley

Railroad (trail site) was built to Newville in 1837 and operated until the mid-1900s bringing fishermen regularly from Harrisburg and Philadelphia to fish the legendary waters of the Creek (Map 5).

Newville has an exit off I81, the main north/south artery in the Cumberland Valley (Map 5). The Pennsylvania Turnpike runs east/west, approximately 3 miles outside the Borough but there is no direct link to the watershed area (no Newville exit). The scenic Big Spring Road (State Route 3007) runs along the Big Spring Creek and bisects the watershed area. Newville is a self-sufficient town with a full-service grocery, a pharmacy,and a well-stocked hardware store. Newville's largest celebration is a yearly entertainment and craft vendor event called the Fountain Festival, which is named after the town's historic architectural feature. Many town residents have been living in Newville for generations and can trace their ancestry back to the original land settlers around 1750. As a consequence of this, the Newville Historical Society was begun in 1966. Events are not restricted to the town center itself. The Big Spring Watershed Association (BSWA) has held an annual "Discovery Day along the Big Spring" each year since 2002. Discovery Day is a drive/walk educational/fun event held in four of the PFBC parking lots along the Creek. Big Spring Road (SR3007) is utilized for charity walks in support of MS and has frequently been the site of 5K runs. Because the road traverses a short distance--3.5 miles from town to headwaters--it is extremely accessible and BSWA envisions it utilized and developed as a cultural resource.

Outstanding features of Big Spring are many, and include historical and recovering native and trophy wild trout populations, good public access in the reaches above Newville with five parking areas owned by PA Fish and Boat Commission (PAFBC) and a Rails-to-Trails crossing in Newville, historical mill sites, farms, associated spring houses, and other structures and communities of historical importance. Moreover, the pastoral and scenic beauty of the stream corridor is appreciated greatly by outdoor enthusiasts and the local residents of the watershed. The unique limestone areas at the source and along the corridor are also important habitats for a variety of wildlife. The area surrounding the source springs is recognized as an outstanding geologic feature of statewide significance.

The geology of the watershed area is characterized by karst or limestone features. While buffered from acidity, natural and anthropogenic acids readily dissolve the carbonate rocks, creating preferential flow paths of water through solution channels that typically occur along bedding planes and fractures. This activity is responsible for cave and sinkhole formation within and outside the surface watershed. These features, along with closed depressions, dry valleys, and springs of substantial discharge are typical of karst environments, and should be acknowledged along with inter-basin, regional groundwater flow in any development of groundwater or geologic resources in the area. Groundwater flow velocities can be exceedingly rapid, up to 3 km/day, leaving little time for surface pollutants to be cleansed from the aquifer.

The entire surface watershed of Big Spring to Newville Borough is within the Hagerstown-Duffield Association, a soil association derived from weathered limestone occurring on valley floors and moderately steep slopes and upland areas.

Approximately, 50% of the Big Spring Watershed contains Class I, II, and III Soils. Prime farmland in Cumberland County includes Class I and II soils. Pennsylvania has classified Class III soils as “soils of statewide importance” due to their productive capabilities. Prime agricultural soils (Classes I and II) make up approximately 15% of the surface watershed and are a non-renewable natural resource of deep, well-drained and fertile soil (Map 8).

Since 1989, over 10,300 acres of farmland have been preserved in Cumberland County. The Big Spring Watershed contains approximately 448.3 acres of this preserved farmland on four farms. The Big Spring Watershed is located within a priority area for future agricultural conservation easements based on concentrating preservation efforts on areas surrounding existing preserved farms. The Big Spring Watershed includes approximately 1,900 acres of land enrolled in Agricultural Security Areas within North Newton, West Pennsboro, South Newton, and Penn Townships.

Upper Big Spring is comprised of two major source springs. The west spring provides most flow, and infrequent sediment release, and the east spring provides less but constant, clear flow. Cool Spring is an important contributing spring to Big Spring that presently serves as public water supply to the Borough of Newville. Stage measurements on Big Spring for 1991-2003 show that water level closely follows level of groundwater in the region. Although stage level in Big Spring only fluctuated 8 inches during this time, discharge varied between 16.7 cfs and 62.75 cfs. Therefore, conclusions about impacts of land or water use on flow need to be based on discharge estimates from an accurate rating curve. The U.S.G.S. recently installed a data-logging level gauge and is calibrating level to discharge. This installation was the result of a permit condition for the Pennsy Supply Quarry, permitted within the surface watershed in 2004, to constantly monitor discharge as well as turbidity and temperature.

Important forested floodplain wetlands occur on Big Spring near its confluence with Conodoguinet Creek where they form from flooding of this large-order stream (Map 10) Big Spring does develop some shrub wetland and marshland along its riparian zone in its mid-reaches above Newville. This area is used by a variety of waterfowl, and other wetland-dependent wildlife. Temporary ponds or vernal pools, although they occur outside the surface watershed, form along the base of South Mountain where Big Spring’s waters originate. These wetlands form from karst depressions at depth and are critical habitat for many of the regions amphibians and reptiles. A recent Tri-County Natural Areas Inventory update (2005) noted that temporary ponds near Thompson Hollow (tributary of Burd Run and Middle Spring and a likely contributing source to Big Spring) as a priority conservation area.

Floodplains also occur predominantly near the confluence with the Condoguinet. Since Big Spring itself does not flood substantially, it produces narrow riparian zones for most of its length. Some depressional wetlands form in the watershed due to the karst geology, particularly where soil plugs form in sinks, however there are not major lakes and ponds in the watershed.

The Borough of Newville discharges treated wastewater into Big Spring on the north end of the Borough. This is presently the most substantial permitted discharge into Big Spring. Big Spring school district is also a National Pollution Discharge Elimination System (NPDES) permit holder. The impacts of these discharges have not been thoroughly investigated. One concern given development pressure in the region is that Newville may draw-down flow of Big Spring, directly through expanded pumping or indirectly by drawing down level in adjacent Cool Spring. Decreased flow in the channel, combined with additional hook-ups to the wastewater treatment facility, will further degrade water quality unless concomitant upgrades in treatment are made.

Low dissolved oxygen and PCBs in sediments have been attributed to hatchery effluent below the Big Spring Fish Culture Station when in operation. Sowbugs conducted PCBs from sediments into higher trophic levels (white suckers and slimy sculpins) on Big Spring, and this bioaccumulation was greatest immediately below hatchery outfall. It is uncertain the extent to which PCBs remain in sediments of Big Spring.

The practice of winter-spreading cow manure is common in the surface watershed and along the presumed flow path between Southhampton Township and Big Spring. Limestone regions are most sensitive to non-point pollution, even with careful waste management practices. Given farming practices of manure spreading during the dormant season when there is no crop nutrient demand, waste disposal into sinkholes, and neglect of on-lot septic systems, there is tremendous potential to concentrate non-point runoff into Big Spring and similar streams. Additionally, failed detention basins in developed areas similarly can concentrate contaminants in conduit flow to Big Spring, as sinkholes develop from adding water to, or pumping water from the aquifer.

Due primarily to controversy surrounding closing of the state fish hatchery in 2001, there has been intensive water quality monitoring on Big Spring. Dissolved substances such as ammonia (NH_3), toxic to aquatic organism even in small quantities, and Chemical and Biological Oxygen Demand (CBOD), elevated under high inputs of pollution, have declined substantially in the upper reaches of Big Spring since hatchery closure.

In addition to hydrologic dye tracing, the hydrological study associated with this plan has included background fluorescence measurement of Big Spring, surrounding wells, and surrounding springs. This analysis has detected possible animal wastes in shallow springs near Big Spring (Mt. Rock and others) and also suggests, based on similarities in organic acid content, that wells near Big Spring and most of the springs in the valley originate from a similar water source.

Nutrient monitoring near the source of Big Spring by PA-DEP and by Shippensburg University students routinely records elevated nitrate approaching the EPA drinking water standard of 10 ppm or mg/l. Soluble phosphorus often is elevated over 1 or even 2 mg/l during winter. In summer of 2002 after hatchery closure, upper Big Spring demonstrated some of the highest predawn channel water dissolved oxygen (DO) values measured among area spring creeks (6.3-8.4 ppm). In contrast, values obtained by Black and Macri in 1990s were below 5 ppm, the lower limit for trout. Dissolved Oxygen in trout redds (spawning areas in gravel) or redd attempts was above the critical 5 ppm in winter 2002 and 2003 in seven of ten wells sampled. Even in sediments with higher DO, much gravel was embedded in sand, leading to sub-optimal spawning habitat. Since that time, Putnam et al. (2004) has noted the importance of sandy upwelling areas for brook trout spawning. It is these areas that should be assessed for future spawning substrate studies on Big Spring.

Water quality as inferred from benthic monitoring is well documented for recent years on Big Spring. Initial surveys were accomplished by Eugene Macri, M.S. aquatic biology Shippensburg University, and coauthored with Dr. John Black, aquatic toxicologist, (Black and Macri 1997). These authors found Big Spring dominated by pollution tolerant invertebrates during the 1990s while the PAFBC hatchery was still in operation. Mr. Macri has followed up with a recent survey in 2002 that showed improvement in the stream upon hatchery closure. These results were corroborated by William Botts, water pollution biologist at PA-DEP, in repeated surveys between 1998 and 2004. Critical monitoring of Big Spring's water quantity and clarity is occurring on a continuous basis by a U.S. Geological Survey gauging station situated on the old mill dam structure at the head of the stream. This installation monitors level, turbidity, and temperature.

Trout Populations during the 1970s thorugh1990s were greatly reduced from those found by Cooper and Scherer (1967). According to PAFBC, hatchery brook trout were stocked in Big Spring during the years this survey was conducted (810 adults and 5,000 fingerlings in 1961 and 1900 adults and 2000 fingerlings in 1962) and we do not know their contribution to the survey. Nevertheless Cooper and Scherer (1967) record an abundance of all age classes, typical of healthy wild populations. Populations of native, wild brook trout, as well as of rainbow trout have increased exponentially since hatchery closure in 2001, indicating a return to higher water quality. Care should be taken to differentiate between trout numbers and biomass, as biomass has declined from a loss of large fish which unnaturally dominated the population of the headwaters during hatchery operation. Below the headwaters, trout did not thrive during state hatchery operation. A 2005 survey near the stone arch bridge revealed 7 fish species besides trout. Species composition of fish probably has not changed over time according to PAFBC. Brook trout currently thrive in the upper-most reaches, non-native rainbow trout in mid-reaches, but neither species is thriving below Nealy Rd., where there is lower water quality and less restricted fishing regulations.

The stream corridor hosts high bird diversity (approximately 130 sighted to date), including possible or probably occurrence of species of concern such as black-crowned night heron, American black duck, and Northern bobwhite. Caves and older trees at the source springs provide good bat habitat. Reptiles and amphibians are understudied on Big Spring and other valley springs. The tri-county Natural Areas Report (2005) reports several areas of concern that fall outside of the surface watershed, but likely occur within the true contributing areas of Big Spring. Waterfowl hunting and trapping of small mammals (chiefly muskrat and mink) occurs along the state-owned land on upper Big Spring. Below Newville, land is posted to these consumptive activities.

For riparian and aquatic plants, several species are invasive and therefore of concern. These include Japanese honeysuckle (*Lonicera japonica*), Tatarian honeysuckle (*Lonicera tataria*), multiflora rose (*Rosa multiflora*), and reed canary grass (*Phalaris arundinacea*). Additionally, *Elodea canadensis* (Canadian water weed) is an aquatic invasive that strongly controls sediment dynamics within the channel (Clapsaddle 2003). *Potamageton crispus* (curly pond weed) also an aquatic invasive, dominates slow deep waters in the middle reaches, and tree of heaven (*Ailanthus altissima*) is rapidly invading disturbed areas along parking areas and roadsides. Garlic mustard (*Alliaria petiolata*) is also listed in the Natural Areas Inventory (2005) as an important invasive in the Condoguinet floodplain. Watercress, water speedwell, and waterweed dominated the reach electrofished by Cooper and Scherer (1967), along with several other species. During years of hatchery operation, Big Spring was overtaken by watercress. Aquatic plant diversity is returning, but there are still occasional large blooms of water cress and algae from non-point nutrient loading.

Fishing is the most popular activity with diverse opportunities available including fly fishing in the upper specially regulated Catch and Release Fly Fishing Only reach and spin/bait fishing opportunities in the lower section. It is typical to see out of state licenses on cars parked along the stream, reflecting Big Spring renown as a trout fishery. Recreational hiking may see a boost if the Cumberland County Rails to Trails sections from Newville to Oakville or Newville to Carlisle are completed. Cumberland County is presently exploring the feasibility of extending the trail from Newville to Carlisle. Additional recreational facilities include the Newville Community Park that offers a large jungle gym, a covered pavilion for picnics, a baseball diamond with restrooms and 3 tennis courts with platforms for skateboarding. The streamside area of the historic Laughlin Mill provides picnic tables and is a popular fishing location for local residents. The PFBC maintains 4 large parking lots above Newville, offering easy access to all ages and physical capacities. One concern is landscaping around these parking lots, which could be improved to beautify the area and prevent runoff and off-road vehicle damage. There is a proposed pocket park near Greenridge Village Retirement Community that would be added once a large housing development along SR233 South is under construction. This would offer additional stream-side ground to residents of Green Ridge Village and West Pensboro Township. Green Ridge Village is presently working with BSWA directors to plan a trail and wildlife-friendly riparian plantings in this area. The winding lane of Big Spring Road provides an unsurpassed scenic byway from the headwaters to the historic Laughlin Mill in town.

A major concern of BSWA is the commercial development of warehouse/truck terminals within contributing areas of Big Spring. Housing development pressures are also increasing in the area. At the time of this writing, West Pennsboro has granted preliminary plan approval to a development on SR223 south of the town of Newville and in the surface watershed. Farming pressures include a large facility, such as a recently proposed hog farm near SR233. Areas to the south and east are zoned and being developed industrially, and these are likely contributing areas to Big Spring or Newville Municipal Spring (Cool Spring). Like any area with karst (limestone) geology, groundwater flow patterns are unpredictable based on surface topography. Springs such as Big Spring are derived from source water areas (recharge zones) far outside their surface watersheds. This characteristic is of paramount importance in protecting Big Spring Creek and its associated springs. Hydrological traces associated with the project have recently demonstrated that rapid infiltration of runoff into sinkholes will pour into the aquifer and be carried directly in limestone conduits to Big Spring. One of the PAFBC hatchery culverts acts as a conduit for roadside runoff to the stream's headwaters. In one rain event in 2005, this resulted in substantial sediment loading to the stream. BSWA would like to work with PAFBC to mitigate this problem. Raceways exist at the old Thomas hatchery site further downstream, on the west side of the stream. These are in ruins and covered with successional forest. They should be examined further to determine if they contribute siltation to Big Spring through outlet pipes, or serve as habitat to wetland organisms.

The west spring of Big Spring is susceptible to sedimentation during strong rain events. This spring is connected to at least one large sinkhole to the west near Shippensburg that occurs, ironically, in a failing detention basin engineered to slow runoff from an impervious surface. A second failing detention basin exists at the Pennsy Quarry site within the surface watershed. The basin contains a sinkhole-drainage of turbid water observed to enter directly into the aquifer rather than percolate through the system of drainage pipes and rock-fill. While this situation was mitigated by PA DEP Mining and Pennsy Supply, it is likely that the drainage will open further with additional runoff and pumping. While this quarry is permitted to blast to sea-level (a depth of about 600 feet), the permit conditions require approval from PA-DEP to continue with each 50' increase in depth beyond the water table. Given the position of this quarry on the down-gradient side of the regional flow pattern (east surface watershed), any likely influence to Big Spring would likely occur on the smaller east contributing source spring or to Cool Spring, another east-contributing source spring that is utilized for public water supply by the Borough of Newville.

It may not be ideal to increase public reliance on spring water given Big Spring's continued down-stream recovery of blue-ribbon trout fishery, sediment buildup behind the Laughlin Mill dam at the proposed point of intake, and potential for rapid contaminant transport to these springs. On the other hand, if limited quantities are drawn off of Big Spring, sediment is removed, and water quality protected, the mill pond in Newville could become a much greater recreational and consumptive resource. There is a build-up of "legacy sediment," i.e. sediment from past agriculture (Clapsaddle 2003) and fish hatcheries (Hurd et al. 2004), particularly behind downstream-structures such as the Rt. 233 bridge and Laughlin Mill dam.

The current, major point-source discharge into Big Spring occurs from the Newville Borough wastewater treatment plant. While the facility appears to adequately treat existing wastewater, there is less capacity than potential future demand based on large developments being proposed in the area. Given the high nutrient levels of Big Spring as it discharges from the regional aquifer, it will be important to continue to limit discharge of additional nutrients and organic matter from wastewater treatment.

A major goal of BSWA is development of a Big Spring Greenway in order to ensure public access for fishing and other recreation. Given PAFBC ownership of most of the first half of the stream and the relatively undeveloped character below Newville, there is good opportunity to secure future, public enjoyment of Big Spring. Newville and the surrounding townships possess in Big Spring a potential economic as well as ecologic jewel of the Cumberland Valley. If water quality and quantity is protected along with public access, local businesses should benefit. Spring creeks are unique ecosystems that are sensitive to wading and boating in terms of stream substrate, bank stability and erosion, aquatic plant life, and benthic communities. The fishery has tremendous potential to offer trophy wild trout. The exponential increase in wild brook and rainbow trout, and increases in pollution-intolerant invertebrates should facilitate re-designation of most of the upper reaches of Big Spring to Exceptional Value (EV) and High Quality (HQ), or Class A status if water quality and habitat is improved. In light of these characteristics, it is important that recreational opportunities be expanded in a sustainable fashion encouraging non-consumptive and light impact activities.

The area surrounding Big Spring would benefit from cohesive, multi-municipal planning. As the Cumberland Valley develops, municipalities will need to plan jointly in order to provide adequate supplies of clean drinking water and sewage treatment, to prevent contamination of karst springs by confined animal feeding operations, quarries, the I81 and I76 corridors, and to minimize the impact of associated activities and development. As related to water resources, this regional focus is particularly critical in limestone areas due to their unique hydrology and lack of ability to filter contaminants. As related to environmental quality of Big Spring and safety of private and public water supplies in this sensitive karst area, careful waste, nutrient, and general contaminant-response planning is required. Continued delineation of source water to Big Spring through scientific study is also necessary to identify sources of non-point pollution. Hydrologic dye traces, such as the one described in this report, should be conducted from areas suspected to be hydrologically connected to Big Spring and Cool Spring, and careful monitoring of nutrients and contaminants should also be continued in order to protect Big Spring and the drinking water quality in Cool Spring.

Big Spring's rural character, restored historical structures, colorful wild trout, and gin-clear waters with constant plant growth make it one of the more beautiful streams in Pennsylvania. Several historic structures occur along its length, including a restored grist mill in Newville, a barrel factory at the source that is currently being renovated by BSWA, and the historic village of Springfield just above the spring's headwaters. BSWA is very interested in working with municipalities and the Green Ridge Village Retirement Community to facilitate handicapped fishing along Big Spring. It is critical that Big Spring maintain its scenic beauty and Newville its historical character. Therefore, development of a service industry fitting for eco-tourism and fishing is encouraged, but not at the expense of the watershed's rural character. Greenway development to promote fishing access and outdoor recreation is a priority, along with silt removal for enhanced water quality and fish habitat, and regional planning that protects the resource from negative changes in water quality and quantity.

Highest management priorities of the steering committee and public who responded to surveys were to mitigate development pressures, coordinate regional planning, protect primary and secondary source waters (Big Spring, Cool Spring, and the related aquifer), mitigate sinkhole collapse in stormwater basins and infiltration galleries, reclassify the fishery to exceptional value/high quality, improve existing dams with focus on the Laughlin Mill dam and associated pond, and develop a restoration and reuse plan for the Barrel Factory, with potential conversion to museum. The public overwhelmingly stated their appreciation of the natural beauty, clear water, and scenic/historic character, as well as the value of the stream itself as a natural resource.

CHAPTER 1 - INTRODUCTION AND STUDY PURPOSE

Big Spring Watershed Association (BSWA) formed in 2001 with the goals of protecting and managing wild native trout populations of Big Spring, and the other natural, cultural, and historical resources of the watershed. This plan reviews these resources in detail, relying on a broad array of partners and public input, in order to provide best possible information to policy makers and to prioritize project opportunities for meeting these goals. These priorities are provided in the management matrix (Appendix 6). The plan was prepared with a matching grant to BSWA to begin delineation of contributing areas through hydrogeological study, with the assistance of Pennsylvania Environmental Council staff and other input noted above, and with authorship by BSWA board members. It is the hope of BSWA that completion of the plan will facilitate effective conservation of the water and other natural resources of Big Spring. Specific outcomes of the plan are:

1) increased awareness and voiced priorities of residents and other public who utilize Big Spring;
2) integrated goals and planning among surrounding municipalities, BSWA, and other private and public stakeholders; and
3) formal recognition (e.g. River Registry through Pennsylvania Department of Conservation and Natural Resources) and resource allocation fitting for this productive fishery, water supply, and natural area.

CHAPTER 2 - PROJECT AREA CHARACTERISTICS

Watershed

Surface watershed location and size

Big Spring and its topographical surface watershed are located in Cumberland County, Pennsylvania twelve miles west of Carlisle, PA (Map 1). Big Spring serves as the boundary between North Newton and West Pennsboro Township and flows through the Borough of Newville to Conodoguinet Creek. The surface watershed is approximately 12.2 Mi^2, with maximum elevation of 847 feet occurring near Interstate 81 and the Yellow Breeches Watershed (Map 2). Small sections of Penn and South Newton townships extend into the surface watershed. The lowest elevation of 480 feet occurs north of Newville at the confluence with the Conodoguinet. Big Spring is the 5^{th} largest spring in Pennsylvania, and is recognized as a site of state significance in the Natural Areas Inventory (2005) and as a major greenway of Cumberland County (Land Partnerships 2006).

Hydrological Dye Trace Shows Contributing Areas Outside the Surface Watershed

BSWA, in partnership with Shippensburg University, has begun determining regional contributing areas to Big Spring that lie outside of the surface topographical watershed. With funding from the Alexander Stewart Foundation of Shippensburg to BSWA (a match to this project) and additional funds from the State System of Higher Education, initial traces were conducted in late summer and early autumn of 2005. The probability of regional, unpredictable contributing areas to Big Spring have been generally acknowledged by knowledgeable scientists and citizens, but specific source areas and flowpaths were not previously documented. The stream and surrounding region are characterized by karst, or limestone topography where groundwater flow occurs preferentially through limestone fractures, conduits, and caves, and often between surface watershed divides. Surpisingly, the South-Central PA Mining Office of the Pennsylvania Department of Environmental Protection (PADEP) permitted a quarry within the surface watershed without consideration of these well-known features of groundwater flow in karst. It based its decision on a hydrological model that assumed no conduit flow and shallow, low-yielding well data that showed groundwater flow perpendicular to the flow paths determined by dye tracing. While results to date indicate part of Big Spring's flow originates far up-valley, close to Shippensburg, it is clear that more such work will be necessary in order to delineate the true contributing area to Big Spring and its contributing springs. Water did not appear to flow directly from the Yellow Breeches Channel, across the valley to Big Spring. Rather, tracers indicated linear flow patterns down-valley, following geologic strike (orientation of bedding plane fissures parallel with geologic folding in the Ridge and Valley Province of PA – Map 7; Figure 15). While most of this plan will address the surface watershed, the area encompassing the documented regional flow needs immediate attention. The dye trace proved direct hydrologic connection between runoff from impervious surfaces to Big Spring, via a sinkhole in a failed stormwater detention basin. Similar sinkholes are common features in the agricultural and developing landscape surrounding Big Spring and serve to concentrate non-point pollution inputs to the aquifer.

Stream Corridor
Land Use
Land use is mixed forested, agricultural, and residential within and near the Borough of Newville (Maps 3 nd 12). Primary land use is agricultural and includes approximately 15% of the watershed designated prime farmland (Map 8). Clapsaddle (2003) notes increases in forest cover between the 1937 and 1999, and the strong potential for legacy sediment (from early forest clearing and agriculture) that may still be impacting the stream. He additionally notes the trend of increasing fragmentation of farms in the watershed into developments and small acreages. Transportation infractructure, particularly bridges and old mill dams impact Big Spring by modifying its natural gradient, hence serving to create backwater sediment traps within the stream (Clapsaddle 2003). Other impacts include stormwater runoff from slopes opposite the road running the length of Big Spring above Newville, sewage treatment plant effluent, and past mining activity that introduced sediment into Big Spring's primary source spring (Chestney 1997). Runoff from above the source springs is exacerbated by the drainage system of the state hatchery that carry water directly into the headwaters.

Ownership, Zoning, and Comprehensive Plans of Municipalities

Most land adjacent to Big Spring is under state ownership with the PAFBC. The PAFBC owns parcels at the headwaters as well as each side of the stream to the stone arch bridge above Newville (Map 4). Most land below this point is privately owned, except for the Laughlin Mill Pond area which is owned by Newville Borough and used by their water authority. Much of the watershed is zoned for agriculture to the east, except within the Borough of Newville, with no zoning in North Newton Township to the west.

Newville adopted a comprehensive plan in 1995, zoning ordinance in 2000, and subdivision ordinance in 1973. Newville is also the only Borough within the county with an open space and recreation plan, created in 1995 (Land Partnerships 2006). Other municipal comprehensive plans and ordinances are summarized in Table 1.

In the agricultural zones, continued fragmentation of farmland can be expected. Agricultural zones in West Pennsboro presently allow two acre lots, with clustered housing. This means that based on 2 acres of agricultural land a house is allowed in a cluster, with 60% of land kept open as a conservation easement within the zone. There are no zoning ordinances on the west side of Big Spring. Wetlands and floodplains are more protected from development, but are not numerous in the area except for near the confluence with the Conodoguinet (Map 10). Commercial and Industrial zones in the eastern portion of the surface watershed (Map 12) will likely result in reduced water quality in Cool Spring (Newville municipal supply), and/or springs to the east given difficulty of proper stormwater management in karst.

Table 1 – Date of last major revision or first enactment of plans/ordinances (from Land Partnerships 2006, as of 2005, and Cumberland Co. Planning Commission).

Plan/Ordinance	Newville Borough	West Pennsboro Township	North Newton Township	South Newton Township	Penn Township
Comprehensive Plan	1995	1991	1973	1971	1997
Zoning Ordinance	2000	1993	None	1987	2006
Subdivision	1973	1998	2001	1997	1999
Open Space and Recreation	1995	None	None	None	None

Regional coordination and planning is critical in karst environments, given dominance of regional groundwater flow that provides for human consumption and healthy spring creek ecosystems. Moreover, the limestone-derived soils over karst support extremely valuable farmland that should be maintained as farmland for the sake of local economies and human food supply. Residents of Cumberland County also recognize the value of farmland and open space preservation, natural resource conservation, and creation of outdoor recreation opportunities (Land Partnerships 2006). To these ends, county, joint-municipal, and municipal plans should be implemented and kept updated in order to provide planned growth, preservation of open space, and best management of farmland for minimal environmental impact on the supporting aquifer of Big Spring.

Social and Economic Profile

Population Centers

The largest population center in the watershed area, both historic and present day, is the Borough of Newville. Two other minor centers of population are Springfield above the source springs and Stoughstown, directly south of the headwaters on route 11. All three towns share a rich cultural and industrial history from the area's settlement around 1735.

Newville, Springfield and Stoughstown are linked by the Spring Road (now Big Spring Road or State Route 3007). Big Spring Road follows the waterway and crosses over it twice via bridges, one modern iron and one stone double-arch dating to 1872. Big Spring Road was originally based on a footpath and in 1857 was turned into the Newville-to-Stoughstown Turnpike. These early turnpikes served to move goods throughout the Cumberland Valley. During their time of operation, Newville's industrial output included six operating flour mills (Map 11), a large whiskey distillery, shoe makers, blacksmiths, three tanneries, saddlers, cabinet and chair makers and eleven brickmakers.

Stoughstown is located on the main road (the Ritner Highway now PA Route 11) that runs from Carlisle to Shippensburg. Stoughstown was a popular stop on the Ritner

Highway turnpike and historians say that it took its name from Mr. John Stough who owned and operated the Sign of the Indian King tavern in 1802. It was later run by Col. John Stough from 1813-1839. A history of the Cumberland County from 1879 mentions that this town "…contained but eight or ten houses, a blacksmith's and a wagonmaker's shop." Today, it has about the same number of dwellings but even less industry although the tavern is still welcoming guests as the Field & Pine Bed and Breakfast.

Springfield was settled on the first public road in the Cumberland Valley which was built in 1735. This road ran from the Harris Ferry on the Susquehanna to the William's Ferry on the Potomac and it crossed the Big Spring Creek at Springfield. Springfield was the location of the most powerful flour mill on the Big Spring Creek, the McCracken Mill which stood approximately 400 feet from the two headwater springs. The mill was not the only business in town as documents mention three taverns, four distilleries, two stores and various mechanics (wagon and hauling suppliers) shops. In fact, around the mid 1800's Springfield was almost designated the Cumberland county seat although this honor eventually was bestowed on Carlisle.

Springfield suffered a major downturn in 1804 when all but four buildings were destroyed in a devastating fire. Today, it is a tiny but picturesque community of some eight homes, including four very fine historic homes dating from the mid 1800's. There is also a United Methodist church and graveyard. At the base of Springfield, next to the Big Spring, is the abandoned limestone structure known as the Barrel Factory. This circa 1860 building may have once contained a tannery; however, later in its history, it produced barrels used for flour storage at the nearby mill. BSWA hopes to restore this building and turn it into a museum highlighting the area's cultural and industrial history, its geology, Big Spring's fishing history and trout habitat restoration efforts.

The town of Newville was always the production capitol of the watershed area. With its constant spring-fed water flow, the Big Spring Creek was harnessed for early industry. Newville's most prosperous period was between 1870 and 1950 with a 1934 business directory listing 50 different places of business. As with many small towns, the commercial reality is vastly different today.

Newville Borough was incorporated in Feb. 26, 1817 and it has a present population of 1,330 (U.S. 2000 Census). The median age is 34.5 and average household is 2.29 individuals. The population is Newville is extremely stabile as evidenced by its 1990 Census that lists a resident total of 1,349. The town was settled by Scots Presbyterians and its racial makeup reflects this with 97.46% Caucasian. Newville was once known as "the town of churches" with over ten listed between 1900 and1950 and today it still includes four houses of worship in town and many more in the surrounding area.

School System

The Big Spring School System consists of five elementary schools, Newville Elementary within the Borough and Frankford, Mifflin, Oak Flat and Plainfield outside the Borough. There is one middle school and one high school located across from each other at the

Borough limits. As of 2006, the Big Spring School District student population is 3,095 and the school system employs 420 persons. Franklin and Mifflin schools are going to be closed at the beginning of the 2007-2008 school year and housed at the old middle school to be called Mount Rock Elementary School.

Economic Development

Newville's first industries were founded on the water power provided by the Big Spring Creek with the Laughlin Mill dating from 1760-1763. Auxiliary service businesses were founded as needs arose, i.e., stables and harness makers/repairers, blacksmiths, wagon makers to maintain the horses and wagons carrying products on the toll road. In addition, early tourism to Newville started with fishermen who began traveling to the area around 1829 when descriptions of the legendary Big Spring brook trout were published in sporting journals.

Newville's most prosperous period, as mentioned previously, was between 1870 and 1950. The Cumberland Valley Railroad was in full operation during this period carrying goods and tourists from Carlisle and through Newville to Shippensburg. Newville began to lose businesses both during and after the Great Depression although a thriving downtown area was maintained until 1950. One local citizen describes Newville's downfall as beginning with the movie house fire in 1950. This movie house was a major draw for country folk and town residents alike as they took in some entertainment and did their shopping each weekend with stores staying open until 10:00 p.m. After the fire, many locals gravitated to Carlisle where both activities were available. As a result, Newville's downtown declined.

A general loss of business continued through the 1980's when most of the remaining large industries including the Newville Shoe Factory, U-Wanna-Wash-It Dress Factory and local Agway closed. East of Newville--Harrisburg and its environs, Carlisle and Boiling Springs expanded with business and housing developments. West of Newville, Shippensburg saw growth at the State University, in business and housing. Newville saw minor housing expansion and virtually no new business.

In 2002, after failing to attract tenants for the vacant manufacturing buildings, the Newville Borough turned to the concept of Ecotourism as a way to develop revenues without sacrificing quality of life. Partnering with the Cumberland County Redevelopment Authority, the Borough Council decided to take advantage of the town's proximity to outdoor attractions that include not only the Big Spring Creek but the Colonel Denning and Pine Grove Furnace state parks (located on North and South Mountain respectively). The development of ecological and heritage tourism became the cornerstone of Newville's Town Center 21 Plan.

The Newville streetscape was improved with money from the Small Town Revitalization Plan that provided turn-of-the-century style lighting, street repair and improved cross walks with brick accents. The next major improvement and cornerstone of the ecotourism concept was the building of a trailhead center and parking lot at the

Cumberland Valley Rails to Trails juncture with Newville (Map 5). The trailhead center provides restrooms, a water fountain and a generous parking lot and it was finished in the fall of 2004. Restoration of habitat and increased fishing opportunities, provision of a handicap fishing access, a greenway along the entire length of the Creek (Pennsylvania Fish & Boat Commission owns varying widths on either side of the Creek starting at the Spring's headwaters and continuing for 2.4 miles), establishment of BSWA's Barrel Factory Museum & Big Spring Education Center at the headwaters, and enhancement of the walking and biking opportunities, would all have a positive impact on the Borough. These improvements would encourage the establishment of small business to support outdoor activities (e.g. bike/fishing equipment rentals) and in addition would provide services such as restaurants and shopping.

Transportation Systems

The early turnpike roads were discussed in a previous section. The Cumberland Valley Railroad was built to Newville in 1837 and passenger service operated until the 1950's although freight deliveries were still made in Newville until the 1970's when service was completely discontinued. In the important fishing history of the Creek, this railroad brought fishermen from Harrisburg and Philadelphia to fish the legendary waters of the Big Spring.

Newville has an exit off I81, the main north/south artery in the Cumberland Valley (Maps 1, 5). The PA Turnpike runs east/west, approximately 3 miles outside Newville but there is no direct link to the watershed area (no Newville exit—nearest turnpike exits are 15 miles east at Carlisle or 23 miles west at Blue Mountain). The scenic Big Spring Road (State Route 3007) runs along the Big Spring Creek from Newville and bisects the watershed area in half from north to south until it hits Route 11 linking the upper surface watershed with Carlisle (12 miles to the east) and Shippensburg (8 miles to the west). The 2000 Newville Census lists an average commute time of 29.6 minutes which is slightly higher than the U.S. average (27.9). Approximately eighty four percent of watershed residents commute in private cars with 10.6 percent car pooling and 1.8 percent of the population working at home. The area is not presently serviced by any mass transportation methods. There is one established carpooling lot at the Newville exit off I81.

Major Sources of Employment

Historically, Newville was at its most prosperous in 1934 with over 50 businesses. Today most of the town's work-age residents commute to Carlisle and Harrisburg area to work. Newville's main businesses and employers are: Pepsi-Cola Distribution Center, Newville Ribbon Mill, Green Ridge Retirement Village, John Walters Trucking, Saylors Market and the Big Spring School System. Medical care for humans and animals are respectively provided by the Graham Medical Center and Farrell Veterinary Clinic and there are pharmacy services by MGM Pharmacy. There are also approximately 25 small individual businesses within the Borough. The watershed area is still largely agricultural and beside family farms, there are Amish/Mennonite greenhouses and farmstands, garages and lawn equipment suppliers/repairers.

The Pepsi-Cola Distribution Plant has an interesting history as it is the original site of the Cloverdale Spring Company's bottling plant. This pure spring was discovered in 1865 when prospectors were drilling for oil north of town. In 1918 they laid a three-mile long underground pipe from the spring's source to the plant location and used this water to make sodas under the Cloverdale name (their old bottles regularly turn up at local auctions and are much sought by local residents). In 1961 the company was purchased by Allegheny Pepsi-Cola and a new plant was built and opened in 1964 to the present day.

History

Big Spring has been vital to the historical development of the area surrounding it. Much of the human activity in the area around Big Spring has centered on use of the spring—particularly since white settlement the construction and operation of grist mills at various points along the stream (Map 11). Big Spring enjoys a rich history that continues to resonate into the present and future.

American Indian Life

Very little is known about the American Indians who lived near or along Big Spring before European settlement. In general, in the beginning of the 17th century, the area of the Susquehanna River was held by the Susquehhanock Indians. Captain John Smith of the Virginia colony encountered the Susquehhanocks when he sailed up the Susquehanna in 1608 at what is today Washington Borough in Lancaster County. During the early part of 17th century the Susquehannocks enjoyed trade with both the English and Dutch in the area. However, warfare in the so-called Beaver Wars with the Iroquois to the north in the mid-17th century severely weakened the Susquehannocks. By the early 1670s they had been pushed to the south toward Maryland and had been for the most part scattered and destroyed as a tribe. Thereafter the Susquehanna Valley was inhabited by refugees of the various tribes destroyed by the wars. (Wallace, 1986) There is some evidence of various Indian settlements near the mouth of Conodoguinet and other parts of the Cumberland Valley, possibly of the Conoy tribe, dating from the early 1700s, but it is not certain which tribes these were. (Kent, 1989)

European Settlement

Lands west of the Susquehanna River were not purchased by the Penn family until October 1736. Prior to the Penn acquisition, settlements in these lands were established through the individual purchase of special licenses In 1732 William Blunston, a land agent for the Penn family, began issuing such licenses to prospective settlers in Big Spring area and by 1735 land on both banks of Big Spring was claimed and occupied. (Kressler, 1965) Reports state that that the first white settler along the Big Spring was Andrew Ralston in 1728. (Rife, 1965) In 1737 William Laughlin donated 89 acres for what became the glebe of the Big Spring Presbyterian Church. (Swain, 1997) Sometime in 1737 a log meeting cabin was erected just north of the present day Presbyterian Church's graveyard. This structure was used until 1790 when the present stone building was constructed. (Woods, 1965) The Borough of Newville had its origins in 1788 during the pastorate of the Reverend Samuel Wilson, the minister of the Big Spring Presbyterian Church. At this time the Big Spring Presbyterian Church was incorporated. Its incorporation gave the board of trustees the power to convey legal title to lots and other lands. By 1790 the trustees surveyed the land around the church and began to select names for streets and alleys—thereby laying out the future town of Newville. Subsequently, sixty lots were sold from the church's glebe, with the first lot bought by William Laughlin for $213. Lots that bordered Big Spring were most valuable and sold for $50, while pasturelands brought in $24 to $27 and less desirable lots as little as $8. The Borough of Newville was incorporated in 1817. (Kressler, 1965) The Borough grew in the late 18th and early 19th centuries as a trading point between Carlisle and Shippensburg and also as a jumping off point for points further west through the Roxbury Gap and beyond.

The Mills

The use of Big Spring quickly became central to the area's economic development. With the constant temperature of the spring that prevented freezing during the winters and the consistent water flows unhampered by floods in the spring and drought in the summer, Big Spring was highly advantageous for the operation of grist mills. Very soon after white settlement, mills were constructed along the course of Big Spring with four above Newville and two in or below the town.

> *McCracken Mill*: This was perhaps the most important mill along the course of Big Spring. It was situated about 500 feet below the source of Big Spring. It was constructed probably shortly before 1784 and had several different owners during its operation. With its position near the headwaters, the mill could operate at a higher capacity with its swifter flow of water. In the area above the mill dam was a pond that stored the water for powering the mill. The amount of water flowing into the mill wheel housing could be adjusted, thereby allowing an adjustable amount of power produced by the mill. With a dam level of about seven and a half feet, the McCracken Mill produced at least double, if not triple the horsepower of the other mills along Big Spring. (Kressler, 1965 and Clapsadle, 2003)
>
> The McCracken Mill was sold to the Commonwealth of Pennsylvania in 1939 for $9,000 and the mill was shut down in 1941. The then dilapidated mill was eventually dismantled in 1960 despite protests from local citizens. (Kressler, 1965 and Clapsadle, 2003)
>
> Near McCracken Mill at the headwaters of the Big Spring emerged a bustling community of houses named Springfield. During the time of the Civil War, in addition to the grist mill, Springfield boasted around 50 dwellings, a store, a

tavern, a schoolhouse, a tin shop, two barrel factories, an ore bank, 2 saddler shops, 3 shoe maker shops, a saw mill, and a tannery. It reached its maximum population of about 200 residents. Because of its location along routes between Philadelphia and Pittsburgh it enjoyed considerable economic activity and supposedly was considered for the county seat of Cumberland County in the mid - 19th century. However, the refusal of one of its citizens to allow the extension of its main street to flatter ground prevented Springfield from achieving greater prominence. (Rife, 1965) Today all of the businesses of Springfield have disappeared and what remains is a collection of houses and farms.

Piper Mill: This was reportedly the second mill to be constructed along the Big Spring with reports indicating its construction as early as the fall of 1763 and possibly as late as the 1770s. This mill operated from 1774 to 1952 by three generations of three different families—the Pipers, Hursches and Bakers. Between 1890 and 1893 Andrew Oyler operated the mill. The dam was removed in 1924 and mill torn down in the early 1930s (Kressler, 1965 and Clapsaddle, 2003). In the early 1950s the land where the original mill stood was sold to Colin Thomas who rebuilt a new and higher dam than the previous one. However the new dam did not have gates for sediment flushing. Thomas used the dam to divert water for the Green Spring Trout Company hatchery, which was established in 1953. Production at the hatchery reached 300,000 to 400,000 fish by 1957. In 1958, the Pennsylvania Fish Commission determined that the effluent from the fish hatchery seriously compromised the fish population—leading to a dramatic decrease of brook trout below the hatchery. In 1968 the hatchery was closed and in 1994 the dam was removed. (Black and Macri, 1997)

Keck Mill: This mill, sometimes known as the Irvin Mill, was located just downstream of Nealy Road. It was constructed sometime after 1786 when the patent for the land was issued to James Irvin. The mill changed through several hands in its history with Harry Keck buying the mill in 1924 and operating it until 1935. This mill was built with an undershot wheel which was driven by the water flowing from the mill pond above. The fall of water was a relatively short one of about four feet and the mill could only generate about eight to ten horsepower—producing about eighteen barrels of flour a day. Keck dismantled the mill in 1940 with practically no remains of it today. (Kressler, 1965 and Clapsaddle, 2003)

McFarland Mill: Just below the stone arch bridge, at the site of the existing bridge to Green Ridge Village was the site of the McFarland Mill, the fourth mill along the Big Spring. This mill was constructed sometime around 1756 and depended on the "run of the river," meaning that the mill was an overshot wheel that depended on daily flows as opposed to the mill dam capacity. Over its lifetime, the mill acted as a flour mill, paper mill, and finally as a knitting mill. In 1943 Henrietta Sharp donated the mills and its land to the Presbyterian Home of Central Pennsylvania. The mill and dam were dismantled in the 1950s. The present-day bridge across the Big Spring to Green Ridge Village is where the former mill stood. (Kressler, 1965)

Laughlin Mill: This lone existing mill on the Big Spring sits just upstream of the State Route 641 in Newville (Figure 1). The origins of the Laughlin mill are not completely known. The William Laughlin family built the mill sometime before 1763—most likely between 1760 and 1763. There may have been a grist mill at the site beforehand and Laughlin constructed a new mill where it stands today. The mill was operated by three generations of Laughlins before being sold to the Newville Water Company in 1896. The mill's machinery was sold off and the power from the mill was used by the water company to pump water through the mains in town. In 1916 the original look of the mill was restored by Ethel McCarthy. Later the water wheel was restored by two faculty members of Big Spring High School. (Kressler, 1965)

Ginter Mill: This was the last of the six mills along the Big Spring. Gabriel and Alexander Gleim constructed the mill sometime during the Revolutionary War. The mill had several owners, including Peter and Daniel Ahl in the mid-19th century. In 1904 James Ginter purchased the mill and operated it with his son until it ceased operations in 1935. During this time Ginter made extensive improvements to the mill, including the construction of a new concrete dam that heightened the fall of the water of the dam to six and one-half feet. After the mill's end of operations in 1935, no efforts were made for maintenance. Although reports indicate that the mill still stood in the early 1960s, today only some of the mill's foundations still remain. (Kressler, 1965 and Clapsaddle, 2003)

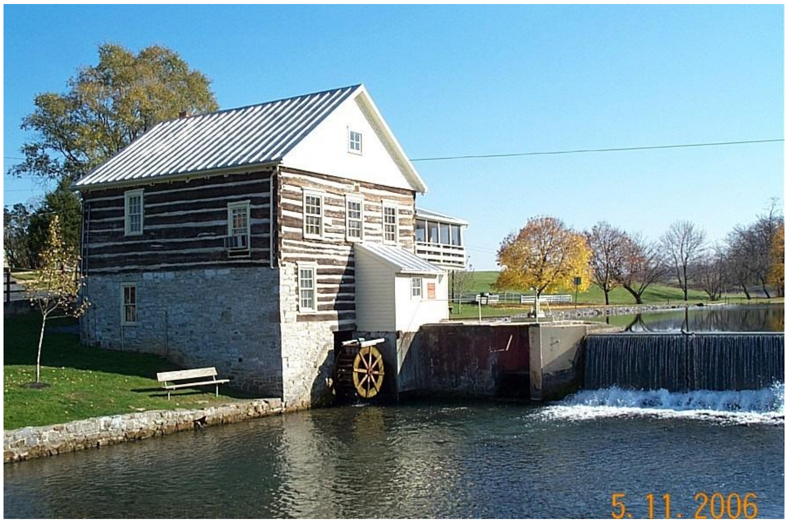


Figure 1 - Laughlin Mill (Photo Jean Coates)

Other Historical Buildings and Sites

The Barrel Factory: Near the headwaters of the Big Spring sits one of the remaining structures of a group of buildings that at one time surrounded the McCracken Mill (Figure 2). Known by locals as the "barrel factory," the

Commonwealth of Pennsylvania bought the two-story building in 1966. Now in a state of disrepair, the building has been leased by BSWA with the goal of renovating the building and transforming it into a museum and educational center. The origins of the barrel factory have not yet been fully investigated, but initial research indicates that the barrel factory was built no later than 1862 when it was sold to George Carothers on its own separate deed. Its earlier origins are not clear as the building stands on the property of the grist mill at the headwater of the Big Spring built by William McCracken and Samuel Finley sometime around 1784. Records relating to the attempted sale of the property in the late 1780s indicated a still house and other buildings surrounding the mill. It is not clear if one of these buildings was the barrel factory. In the twenty years before the Civil War, the village of Springfield was a vibrant commercial center with several stores, shoemakers, a tannery, a saw mill, two saddler shops, and two barrel factories—one of which might have been the building now called the barrel factory. In addition, tax records from the late 19th century indicate that the building might have had multiple uses during its history, including as a store or cooperage. Between 1926 and 1966, except for four years during the 1930s, the building was owned by Henry and Anne Stackhouse who used it as a summerhouse. (Franz)

Figure 2 – The barrel factory on upper Big Spring (Photo Jean Coates)

Outstanding or Unique Features

Wild Trout Populations

Big Spring was historically known as a stream that supported tremendous brook trout production (Chestney 2005). He notes how these native trout made Newville a destination for early fly-fishers after 1850:

"Big Spring Creek has enjoyed a glorious background in the annals of American trout fishing. A native brook trout population of unbelievable size and numbers made this stream a haven for many early anglers and Newville, PA, located on its banks became known as trout town. With access out of Harrisburg by the Cumberland Valley Railroad and having several hotels, this small friendly town, had all the trappings early American anglers required to make it a favorite. As early as 1829, Big spring Creek and Newville were featured in articles written for the sportsmen's magazines of that era. An extremely popular early American fly was dubbed the "Newville."

Some of the earliest conservation measures adopted in America may have been originated on this stream with the establishment of a creel limit in 1850 of 50 trout per day. Mill owners and other cooperative land owners had the foresight to realize the brook trout were not dispensable. They petitioned the state legislature to enact special regulations for this stream. They also established an open fishing season during the months of June, July, and August only, again by having the legislature enact special legislation. Copies of these laws are in the archives of the state legislature, and these regulations, unique to the stream alone, remained in effect until the Pennsylvania Fish Commission came into being and established state wide regulations."

Cooper and Scherer (1967) documented wild brook trout (*Salvelinus fontinalis*) production occurring in Big Spring at rates 5 times that of a typical Pennsylvania freestone stream prior to opening of a large state hatchery by PAFBC in 1972. Such high fish production is typical for limestone spring creeks. However Big Spring is unique among Pennsylvania spring creeks in that brook trout historically dominated the stream. Cooper and Scherer's results indicated native trout biomass of 231 kg/ha between the headwaters and the site of the Thomas hatchery. Subsequently, wild trout were largely absent from most of the stream until the hatchery ceased production in 2001 (Lorson et al. 1987; Appendix 3), but subsequently their populations have resurged. The PAFBC has electro-fished the stream annually in recent years, and the wild brook trout biomass in the upper reaches has increased exponentially with an annual increase of 66% (Figure 3).

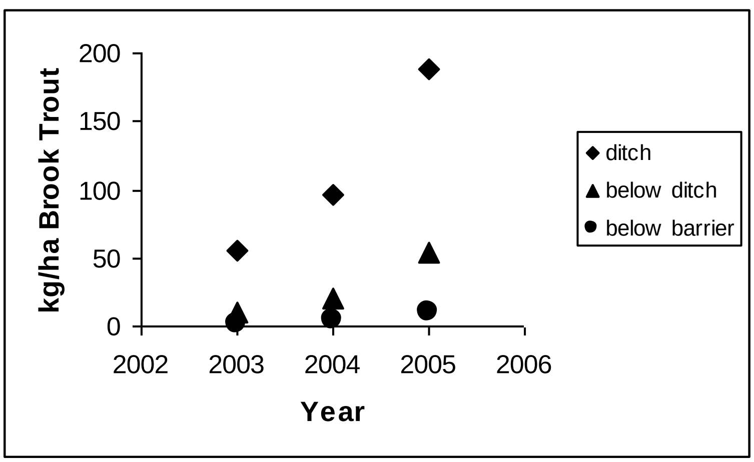


Figure 3 – Exponential increase of wild brook trout in upper Big Spring following hatchery closure, with most increase occurring in the "ditch" or headwaters, and 300 m reach below (the approximate area surveyed by Cooper and Scherer 1967).

Upon hatchery closure, population age-structures were inverted, i.e. with many more large fish than small, young-of-year fish (Figure 4). This pattern, in comparison with the historic age structures of Cooper and Scherer (1967), and the current age structures of the recovering brook and rainbow trout populations (Figures 5, 6), indicate that biomass of trout in the upper-most reach, although impressively large, was the result of fish originating from stocking rather than from natural reproduction. Brook trout appear to be out-competing non-native rainbow trout in the upper reaches, while below the structure that was associated with the Thomas fish hatchery, rainbow trout are increasing exponentially through natural reproduction. Brown trout persist at low densities in the lower reaches (Figure 7). It is thought that brook, and possibly rainbow trout currently and historically out-compete introduced brown trout due to their ability to utilize groundwater upwelling zones in sand or fine substrate (Carline 1980).

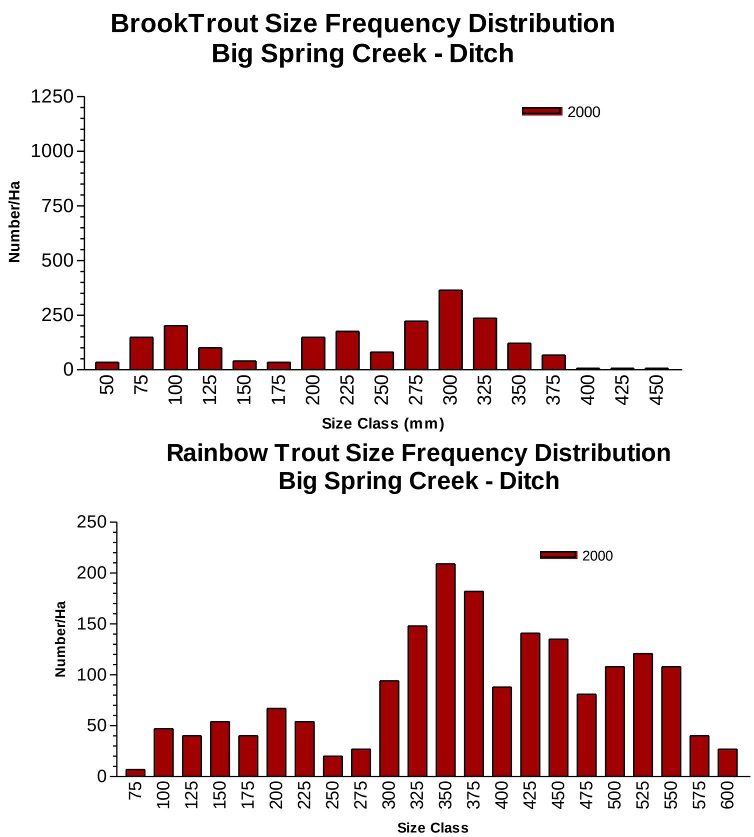


Figure 4 – Inverted size/age class distributions of brook and rainbow trout in the "ditch" or headwaters, demonstrating hatchery origin of trout in the headwaters during hatchery operation (2000). Data Source PAFBC, summarized by PADEP.

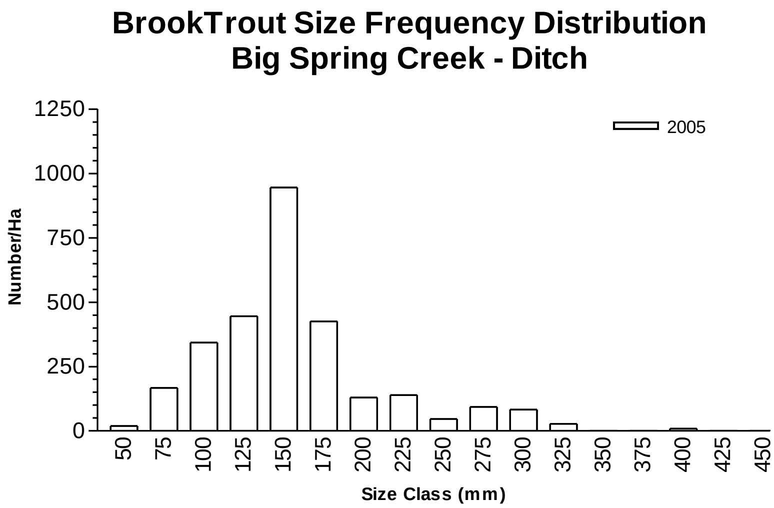
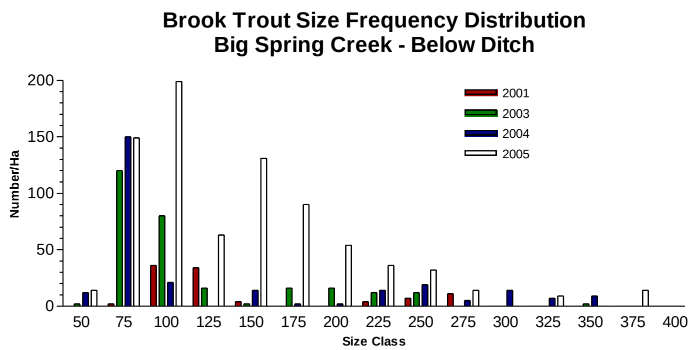
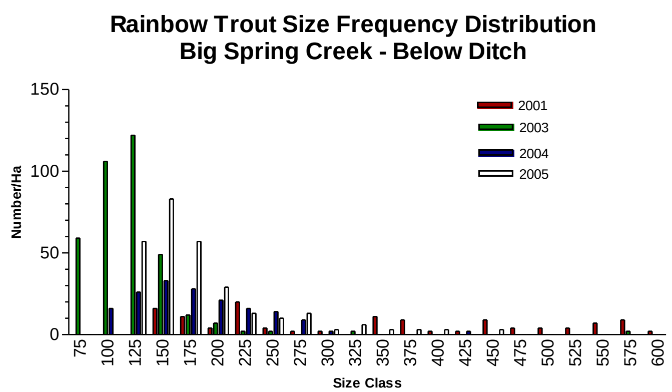


Figure 5 – Wild size/age class distributions of brook trout in the headwaters in 2005, indicating a healthy, self-sustaining wild population. Data Source PAFBC, summarized by PADEP (counts are for unmarked, wild fish).





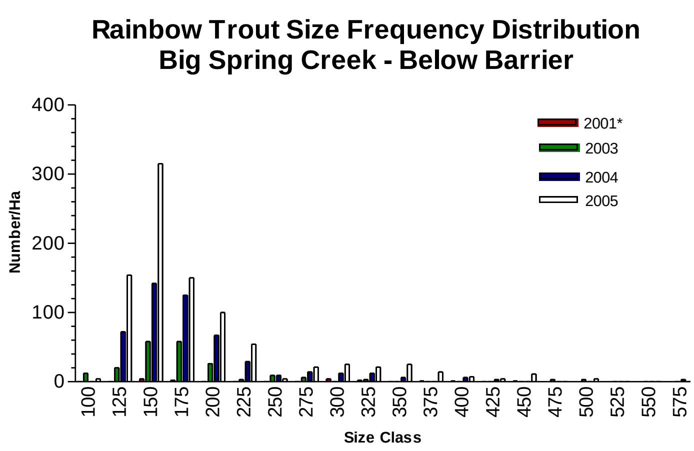


Figure 6 - Wild size/age class distributions of brook and rainbow trout repopulating the stream below the "ditch" or headwaters since hatchery closure in 2001. Data Source PAFBC, summarized by PADEP. Counts are for unmarked, wild fish.

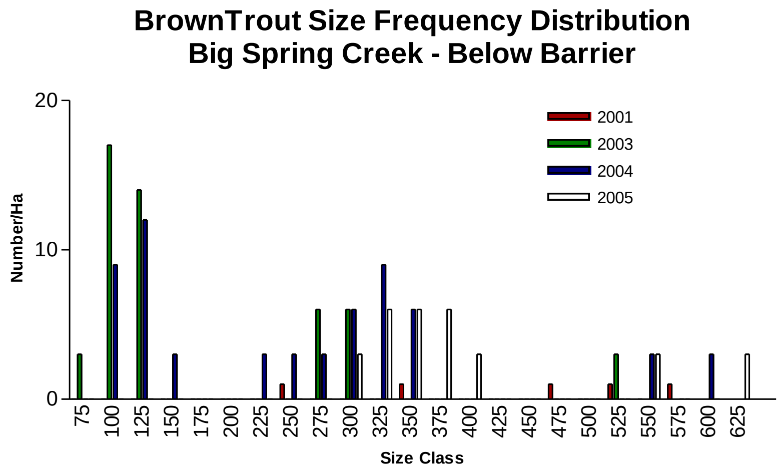


Figure 7 – Age class distribution of brown trout (*Salmo trutta*) in Big Spring, showing low densities and inconsistent annual reproduction (lack of young-of-year fish in the 75-150 mm range). Data from PAFBC, summarized by PA-DEP.

In summary, wild brook and rainbow trout populations are returning strongly to Big Spring in numbers and biomass sufficient to reclassify the associated reaches to Class A High Quality Trout or perhaps extended Exceptional Value status. Big Spring could become a unique destination fishery, as it once was, characterized by remarkable growth and numbers of wild brook trout in the upper reaches (Cooper and Scherer 1967). In addition, non-native rainbow trout are re-colonizing mid-reaches of Big Spring.

Figure 8. A trophy wild brook trout from Big Spring during the 2004 PAFBC electrofishing survey. Photo by T.M. Hurd.

Exceptional Value Status

Big Spring is presently classified as Exceptional Value (EV) water in its headwaters only. The PFBC lists the upper 0.6 mi. as Class A for brook trout. Given the exponential increases in wild trout populations (Class A Wild Trout qualifier for EV (PA Code 93 4b) and improvements in the benthic community (Botts 2004), it is likely that Class A High Quality or perhaps EV status will be extended downstream given sufficient habitat and continued supply of quality spring water. Big Spring arguably is indeed a “surface water of exceptional ecological significance,” another criterion for EV (PA Code 93 4b), as evidenced by its historical wild brook trout production (Cooper and Sherer 1967), biological diversity (see section below), recreation potential, and scenic beauty. The PA DEP has recently recommended the following classification (Robert Schott – Pers. Comm.):

Source to SR 3007 (T 333) - Exceptional Value
3007 (T 333) to old Thomas Dam - High Quality-Cold Water Fishery
Old Thomas Dam to mouth - Cold Water Fishery.

Rural Character

Big Spring is unique among the Cumberland Valley limestone streams in that it presently maintains rural character for most of its length except for its passage through Newville. Even this reach includes a restored grist mill (Laughlin Mill) and public ground surrounding the associated mill pond. Similar trout streams in the region, such as the Letort in Carlisle and Falling Spring in Chambersburg are subject to greater human impacts as they flow through these larger towns. Land cover is a mix of farmland and forest, with several historical structures such as limestone farmhouses, the restored Laughlin Mill in Newville, and the barrel factory at the headwaters. Behind the pastoral views from the stream however, lie features such as high density trailer and retirement home dwellings, as well as increased development pressure on farmland and industrialization on the outskirts of Newville. Nevertheless, the stream’s corridor is unmatched in beauty by other Pennsylvania spring creeks. The local public clearly prioritized the scenic beauty of the watershed in the surveys associated with this plan.

Geological and Ecological Features at Source
Caves and Springs

The PAFBC-owned property surrounding the source springs includes several unique and outstanding geological and ecological features and is recognized as a site of state importance in the Natural Areas Inventory (2005). The two source springs themselves are unique, discharging groundwater at the contact between the Stoufferstown Formation to the north and the Shadygrove Formation to the south (Map 7). Douglas Chichester, of the U.S. Geological Survey described the localized hydrogeology as follows:

> “The Stoufferstown Formation is a thin band of rock between the Stonehenge and Shadygrove Formation. The springs originate in this area not only because of the shape of the contact between the two formations (funneling effect) but also the

> damming effect of the poor yielding Stouferstown Formation causing the spring to surface at this location."

Dye trace results show that each spring receives source waters from contributing area near Cramer Road, Southampton Township. The west spring issues most of the flow, and appears to be connected to this source by a conduit that conducts water approximately 5.5 miles in three to four days. The smaller east spring did not exhibit a sharp dye breakthrough as did the west, and dye concentration was much lower than in the west spring, suggesting a more diffuse flow pattern. Interestingly, Chestney (1997) writes of Big Spring muddying during rain events due to quarrying activity toward Stoughstown, but with one source spring remaining clear. The east spring has been observed to run gin-clear while the larger west spring was roiled with turbid groundwater in a 2004 rain event, again suggesting greater connectivity of the west spring to surface-associated conduits in the limestone. Several caves are located in this vicinity, including one directly west of the PAFBC hatchery facility and a small cave directly over the discharge point of the west spring. Groundwater upwellings are obvious near the confluence of the east and west springs, and these particular locations are utilized extensively by spawning brook trout during autumn and winter months.

This area is unique for the terrestrial community that exists in the cool micro-climate of the springs. The forest, although small in area, is characterized by old-growth white oak and sugar maple, a species more typical of higher-elevation sites in the Ridge and Valley Province to the north and west. Limestone outcrops harbor unique communities of algae, bryophytes, and ferns and should continue to be protected. The small caves at the source may be important habitat for bats, salamanders, and unique invertebrates.

CHAPTER 3 - LAND RESOURCES

Geology

Big Spring occurs in the Cumberland Valley, part of the Great Valley section of the Ridge and Valley Physiographic Province which extends from Maine to Georgia (Chichester 1996). Geologic materials consist mostly of the Cumberland Valley sequence, sedimentary rocks of Cambrian and Ordovician age. Triassic diabase intrusions or dikes also occur within the eroded sedimentary limestones and dolostones that create the broad valley. To the north, this sedimentary basin is bordered by Blue Mountain, locally known as North Mountain, consisting of quartzitic sandstone underlain by shale and greywacke of the Martinsburg formation (Chichester 1996, Becher and Root 1981). The southern flank is bordered by South Mountain, the northernmost extension of the Blue Ridge Physiographic Province, and is underlain by a sequence of carbonate rocks overlain with a mantle or wedge of colluvium (Becher and Root 1981). This mantle is very thick at the boundary of South Mountain (resistant quartzite) and thins gradually to limestone near Rt. 174 (Walnut Bottom Rd.). In general, geologic units tend east-northeast as a result of the regional anticline that has its axis in South Mountain (Becher and Root 1981, Chichester 1996). The region is peri-glacial, i.e. without direct influence of the most recent glaciations. The limestone is composed of calcite and calcium carbonate from pre-existing rocks that have then precipitated. Dolostone is similar to calcite except it contains more of the element magnesium.

In the section of the Great Valley to the east of Shippensburg, the Conodoguinet drains 506 mi^2, including area to the south of Blue Mountain and most of the limestone/dolomite valley. The Yellow Breeches drains 219 mi^2 from the northern flank of South Mountain and a narrower strip of the limestone/dolomite region (Becher and Root 1981). Additionally, the Conodoguinet drains part of South Mountain via Middle Spring Creek and its tributaries near Shippensburg, Pennsylvania. Middle Spring is the only tributary of the Conodoguinet that crosses the valley up-gradient of the Yellow Breeches. This stream will likely be claimed by the Yellow Breeches in geologic time, as others have been, as it erodes into the colluvium beneath South Mountain (pers. comm. Doug Chichester U.S.G.S.). For now, the recent dye trace has shown that the region near Middle Spring loses water directly to Big Spring, through rapid flow in limestone. Tributaries of Middle Spring and the Yellow Breeches are sinking streams, i.e. their water is pirated to the underlying limestone. Chichester (1996) estimated that 1.72 million cubic feet of water per day is lost to the Conodoguinet from the Yellow Breeches in this manner. Becher and Root (1981) noted that only 3.3 (3.12 cfs) million gallons per day of the estimated 16.8 million gallons per day (26.04 cfs) flow in Big Spring was derived from the surface watershed. While it has been suggested that the remainder came directly south of Big Spring from sinking reaches of the upper Yellow Breeches (Clapsaddle 2003), recent dye traces suggest this is not the case, at least during low-flow conditions of late summer.

It is this hydrogeologic setting that makes Big Spring unique, and produces its clear flow, constant temperature, and buffer against acidity. While the water itself is protected from acidity, natural and anthropogenic acids (carbonic acid from soil respiration and sulfuric and nitric acids from acid deposition) readily dissolve the carbonate rocks, creating preferential flow paths of water through solution channels that typically occur along bedding planes and fractures. This activity is responsible for cave and sinkhole formation in the area. These features, along with closed depressions, dry valleys, and springs of substantial discharge are typical of karst environments (Chichester 1996). It is especially critical that these characteristics be acknowledged along with inter-basin, regional groundwater flow in any development of groundwater or geologic resources in the area.

Soils

The entire surface watershed of Big Spring to Newville Borough is within the Hagerstown-Duffield Association, a soil association derived from weathered limestone and occurring on valley floors and moderately steep slopes and upland areas. These soils are typically deep, well-drained silty loams or silty clay loams and are typically well suited for cropland, pasture and woodland. Major limitations of these soils are slope, erosion, rock outcrops, and sinkholes (USDA 1980). All detailed categories within this association are the “C” hydrologic soil group indicating lower infiltration rates (0.04-0.16 inches per hour (Dunne and Leopold 1978).

From Newville Borough north, the surface watershed is in the Berks-Weikert-Bedington Association. This soil, described as a shaly silt loam, is gently sloping to very steep and formed on material weathered from gray and brown shale, siltstone, and sandstone. These soils are moderately deep and well drained, suitable for cropland, pastureland and woodland. Limitations are depth to bedrock, high content of course fragments, and moderate available water capacity. Detailed soils on the soil survey map indicate that soil permeability is moderately rapid and erosion hazard is severe (USDA 1980). The detailed soils categories within this association are in the “C” and “B” hydrologic soil group indicating mid to lower infiltration rates (0.04-0.16 inches per hour for the “C” group and 0.16-0.31 inches per hour for the “B” group (Dunne and Leopold 1978). The “C” hydrologic soil group is substantially more abundant than the “B” category.

The riparian floodplain soils of Big Spring consist of the Warners silt loam on the upper two thirds of the channel length and Melvin silt loam on the lower third of the channel length. Both soils are categorized as nearly level, deep, and poorly drained (Clapsaddle 2003). The Warner silt loam is specific to riparian soils of limestone spring creeks. These soils have a high water table, moderate permeability, and high available water capacity. Detailed categories are in the “D” hydrologic soil group indicating low infiltration rates between 0 and 0.04 inches per hour (Dunne and Leopold 1978).

Approximately, 50% of the Big Spring Watershed contains Class I, II, and III Soils. Prime farmland in Cumberland County includes Class I and II soils. Pennsylvania has classified Class III soils as “soils of statewide importance” due to their productive capabilities. Prime agricultural soils (Classes I and II) make up approximately 15% of the surface watershed and are a non-renewable natural resource of deep, well-drained and fertile soil (Map 8).

Farmland Preservation within the Big Spring Watershed

Cumberland County administers the Pennsylvania Agricultural Conservation Easement Program (ACE) to purchase agricultural conservation easements from willing landowners in agricultural security areas. Federal, state, county, and local funds are used to purchase land development rights. The farmer maintains ownership of the land and can continue to farm it, but cannot convert the land to non-farm uses. The easement is held in perpetuity and provides permanent protection of farmland. In addition, the landowner of an easement must have a conservation plan approved by the County Conservation District and agree to comply with the conservation practices and implementation schedule in the conservation plan.

Since 1989, over 10,300 acres of farmland have been preserved in Cumberland County. The Big Spring Watershed contains approximately 448.3 acres of this preserved farmland on four farms. The Big Spring Watershed is located within a priority area for future agricultural conservation easements based on concentrating preservation efforts on areas surrounding existing preserved farms.

Agricultural Security Areas

The land must be included in an Agricultural Security Area (ASA) before a state ACE can be acquired. The ASA program does not preserve farmland but promotes farming operations by strengthening the farming community's sense of security in land use and the right to farm. The Big Spring Watershed includes approximately 1,900 acres of land enrolled in Agricultural Security Areas within North Newton, West Pennsboro, South Newton, and Penn Townships.

Percent Public Land

The PAFBC owns both banks of the stream for several miles downstream to the stone arch bridge (over half the stream's length), as well as the area surrounding the closed hatchery and spring source. This later parcel accounts for approximately 2% of the surface watershed.

Critical Areas

Critical areas of concern are the new Pennsy Quarry on the southeastern edge of the surface watershed in Penn Township, and developments occurring directly up-gradient of Cool Spring, Newville's municipal water supply and contributing spring to Big Spring. Other critical areas include distant stormwater drainage patterns into failing detention basins. This would include one on the Pennsy Quarry site, and one far up-valley near the Burd Run/Middle Spring watershed of Shippensburg with known connection to Big Spring as well as other springs that may not yet be known about. The historical quarry upgradient of the springhead and PAFBC property, as well as the PAFBC hatchery infrastructure are also facilitating sediment loading to the stream. Based on dye trace results, all sinkholes up-gradient of the springhead along geologic strike could be considered critical areas.

CHAPTER 4 -WATER RESOURCES

Springs

Upper Big Spring is comprised of two major source springs with the west spring providing most flow and infrequent sediment release. The east spring provides less but constant, clear flow. In the dye trace of 2005, the west spring clearly indicated a sharp breakthrough curve of the dye compared with the east spring. This pattern along with the aforementioned characteristics showed that the West Spring can be influenced by rapid, conduit flow from far outside the surface watershed. The two springs in general however exhibit characteristics of more diffuse flow through the limestone aquifer, demonstrated by relatively constant temperature, generally very low turbidity, and relatively constant discharge.

Cool Spring is an important contributing spring to Big Spring that presently serves as public water supply to the Borough of Newville. Cool Spring has no channel, but is encased by the municipal springhouse where the majority of its flow is piped for treatment and consumption. Some overflow typically occurs from what is not utilized into the channel of Big Spring, where it forms the Laughlin mill pond. The dye that was readily detected at Big Spring's source was not detected at Cool Spring, suggesting a different (and yet unknown) contributing area. In addition to Cool Spring, a number of smaller spring seeps enter the channel between the source springs and Newville (Clapsaddle 2003).

Stage measurements on Big Spring for a period 1991-2003 show that level in Big Spring closely follows level of groundwater in the region, except during extreme precipitation events (Brannaka 2003). Average flow during this period was 30 cfs (PFBC 2003). This information was made possible largely due to the efforts of Jake Cohick, a resident along the stream, who made regular stage measurements. Although stage level in Big Spring only fluctuated 8 inches during this time, discharge varied between 16.7 cfs (February 14, 2002) and 62.75 cfs (March 29, 1994) (PFBC and J. Cohick unpublished data). Therefore, conclusions about impacts of land or water use on flow need to be based on discharge estimates from an accurate rating curve. The U.S.G.S. recently installed a data-logging level gauge and is calibrating level to discharge. This installation was the result of a permit condition for the Pennsy Quarry to constantly monitor discharge, as well as turbidity and temperature.

Tributaries

There are no major tributaries of Big Spring (Map 2), although Clapsaddle (2003) pointed out 13 minor tributaries, most of which were spring seeps with three labeled as intermittent or perennial tributaries. One intermittent tributary of possible concern was noted within the Borough of Newville in relation to its ability to conduct contaminated runoff to Big Spring. In general however, none of these tributaries introduced substantial sediment to Big Spring (Clapsaddle 2003).

Wetlands

Important forested floodplain wetlands occur on Big Spring near its confluence with Conodoguinet Creek, where they form from flooding of this large-order stream (Map 10). Big Spring does develop some shrub wetland and marshland along its riparian zone in its mid-reaches above Newville. Wetland vegetation occurs in this region (Table 2), and the area is used by a variety of waterfowl and other wetland-dependent wildlife. The Federally Threatened Bog Turtle is not known to occur within the Big Spring surface watershed, however has been noted in nearby watersheds within Cumberland County with similar vegetative cover.

Table 2 – Characteristic riparian vegetation of upper Big Spring, and national and regional wetland indicator status (Hurd unpublished data).

Big Spring, Nealy Rd. Wetland	**Indicator Status**	
Herbs	*National*	*Region1*
Typha latifolia L. broadleaf cattail	Obl	Obl
Calamagrostis canadensis (Michx.) Beauv. bluejoint	Obl/Fac	FacW+
Phalaris arundinacea L. reed canarygrass	FacW, Obl	FacW+
Lolium arundinaceum (Schreb.) S.J. Darbyshire, tall fescue	Upl, FacW-	FacU
Sedges (*Carex* spp.)	Obl/FacW+	
Rushes (*Juncus*, *Eleocharis*, *Scirpus* (older taxonomy) spp.)	Obl/FacW+	
Sagittaria L. arrowhead	Obl	Obl
Veronica anagallis-aquatica L. water speedwell	Obl	Obl
Rorippa nasturtium-aquaticum (L.) Hayek watercress	Obl	Obl
Shrubs		
Lonicera japonica Thunb. Japanese honeysuckle	FacU, Fac+	Fac-
Lonicera tatarica Tartarian Honeysuckle	FacU	FacU*
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli common elderberry	Upl, FacW	FacW-
Toxicodendron radicans (L.) Kuntze eastern poison ivy	FacU, FacW	Fac
Rosa multiflora Thunb. ex Murr. multiflora rose	Upl, FacU	FacU
Trees		
Morus alba L. white mulberry	Upl, Fac	Upl
Acer negundo L. boxelder	Fac, FacW	Fac+
Juglans nigra L. black walnut	FacU	FacU
Salix nigra Marsh. black willow	Upl, Obl	FacW+

Temporary ponds or vernal pools, although outside the surface watershed, form along the base of South Mountain where Big Spring's waters originate. These wetlands form from karst depressions at depth and are critical habitat for many of the regions amphibians and reptiles. The recent Tri-County Natural Areas Inventory update (2005) noted vernal pools near Thompson Hollow, a tributary of Burd Run and Middle Spring and a likely contributing source to Big Spring, as a priority conservation area:

> **"THOMSON HOLLOW PONDS** (Southampton Twp.) **SP513a, SP513b, SP513c, SP518**, **-** This site includes a group of vernal pools occurring in a forested landscape. The pools are variously vegetated with grasses, sedges, and rushes. Shrubs such as highbush blueberry and buttonbush are also common. These pools support populations of three plant species of special concern. **SP513c** and **SP518** represent two good quality sub-populations of a Federally Threatened species, **SP513b** represents a fair to good quality population of a PA-Rare species, and **SP513a** represents a fair population of a species of special concern. Along with supporting rare plants, vernal pools can play an important role in helping to maintain the diversity of species in forest ecosystems. Vernal pools frequently only hold water from winter until mid-summer and are not capable of supporting fish species. The lack of fish makes them excellent breeding habitat for amphibians. These pools are often swarming with tadpoles or salamander larvae early in the growing season. The quality of pools and adjacent woods at this site has been degraded by logging. The quality of this site will improve by allowing the woods to regenerate without further disturbance. If logging is to continue in this area adequate buffers should be maintained around the pools and clear cutting should be avoided" (Walnut Bottom Quadrangle Site Map - Appendix 2).

Floodplain

Floodplains also occur predominantly near the confluence with the Condoguinet (Map 10). Big Spring itself does not flood substantially, thus producing narrow riparian zones for most of its length.

Lakes and Ponds

Some depressional wetlands form in the watershed due to the karst geology. This occurs primarily when soil plugs form in sinkholes. However, there are not major lakes and ponds in the watershed. Kochanov (1989) mapped these depressions and sinkholes for a tricounty region including Cumberland County. This resource will be utilized in on-going studies of regional contributing areas of the two source springs, and of Cool Spring in Newville. The Laughlin mill dam provides an artificial pond on Big Spring, although at the time of this writing it is in need of sediment removal.

Water Quality

Point Sources, Waste Water Treatment

The Borough of Newville discharges treated waste water into Big Spring on the north end of the Borough (Map 9). This is presently the most substantial permitted discharge into Big Spring. Big Spring school district is also a National Pollution Discharge Elimination Program permit holder. The impacts of these discharges have not been thoroughly considered, as the rise and fall of Big Spring as a blue-ribbon native brook trout fishery occurred in the upper reaches above Newville. Benthic sampling in the vicinity of the Newville municipal discharge has indicated relatively high invertebrate diversity, including the presence of pollution-sensitive Ephemerellid mayflies (Macri – unpublished data; Botts 2004). However, Bott's study in recent years shows increased impairment in this area. Estimated discharge from the treatment plant is 6-10 gallons per minute (Clapsaddle 2003).

One concern given development pressure in the region is that Newville may draw down flow of Big Spring, directly through expanded pumping or indirectly by drawing down level in adjacent Cool Spring. Decreased flow in the channel, combined with additional hook-ups to the wastewater treatment facility, will further degrade water quality unless concomitant upgrades in treatment are made.

Past Point Sources, Trout Hatchery Impacts

The cold, constant flow of Big Spring attracted trout hatcheries to the stream. The first, Green Spring Trout Company a.k.a. the Thomas Hatchery, rebuilt the dam of the Piper Mill (1760s or 70s – 1924), the second grist mill downstream from the source (Map 11). This hatchery was privately owned and operated by Colin Thomas between 1953 and 1968, during which time the PAFBC determined that discharge from the operation reduced the wild brook trout population by 95%, from 641 above to 31 trout per acre below the hatchery (Black and Macri 1997). These authors note that in 1957 production at this hatchery was 300,000 to 500,000 fish. Chestney (2005) notes the following about the impact of this hatchery:

> "By 1960 the only significant numbers of brook trout were located in an area between the commercial hatchery dam and the road bridge below the uppermost millpond, a distance of less than one mile. Surprisingly after closure of the commercial hatchery, a slight resurgence in the brook trout numbers below this hatchery site did take place."

The PAFBC hatchery operated between 1972 and November 2001. During operation, nearly 20 million adult trout were raised at the facility. For 2001, the hatchery produced over 700,000 adult and about 60,000 fingerling trout for stocking into state waters. In operation the hatchery pumped spring water from its source up-gradient to provide water to a large number of concrete raceways. Wastewater then flowed through a treatment system and was returned to the stream by one of the two culverts close to the source springs. Although a waste-treatment system was present, and maximum daily loads in effluent were not exceeded (PAFBC-pers. comm.), in 2001 DEP determined previously permitted discharges were impairing the stream. For NPDES permit renewal in 2001, DEP decreased allowable maximum daily loads and PAFBC determined that meeting the new discharge requirements was cost prohibitive, so closed hatchery operations. Chestney (2005) notes how a clarifier line was in disrepair for 14 years following a breakage. Given this situation, the size and position of the operation, and the low gradient of Big Spring, it comes as no surprise that associated effluent negatively impacted aquatic life of the stream (Black and Macri 1997). The process of cultural eutrophication, although normally associated with livestock or human influences in which nutrients and organic matter decrease oxygen levels in streams, could have prevented in this case. This well-documented process involves increased microbial activity with addition of nutrients that stimulate aquatic plants and algae. In the case of Big Spring nutrient-rich particulate matter in fish feces and other-wise unassimilated hatchery food were introduced to the stream. The host of other contaminants present in hatchery waste would only exacerbate these negative effects.

Impacts of trout hatchery effluent on receiving streams are increasingly recognized (Camargo 1992; Rennert, 1994; Boaventura et al. 1997), and depend on combination of production and biological and physical attributes of the location (Iwama 1991). Such inputs induce changes in water quality, aquatic plants, bottom fauna, and sediments, potentially to the point of anaerobiosis and associated H_2S production, and may also contain residual chemicals and drugs used in fish culture (Warrer-Hansen, 1982). Low dissolved oxygen, and PCBs in sediments have been attributed to hatchery effluent below the Big Spring Fish Culture Station (Embeck 2000 a, 2000 b). Sowbugs conducted PCBs from sediments into higher trophic levels (white suckers and slimy sculpins) in Big Spring, and this bioaccumulation was greatest immediately below hatchery outfall (Embeck 2000 a). Bioaccumulation or biomagnification of PCBs in hatchery trout results from use of marine fish or fish oil in hatchery food (Carline et al. 2004) where these substances have already accumulated in ocean foodwebs. Hatchery fish and organisms that eat hatchery fish or organic waste from the hatchery then further concentrate PCBs and other contaminants. It is uncertain the extent to which PCBs remain in sediments of Big Spring, a matter for testing prior to any dredging activities for habitat or mill-pond restoration. Hurd et al. (2004) documented the reliance of pollution-tolerant sowbugs on hatchery-based carbon in Big Spring, as well as below Huntsdale State Fish Culture Station, by using isotopic tracing techniques. Combined with Embeck (2000a), this demonstrates that the natural food web was completely altered, with diverse plants replaced by contaminant-bearing hatchery material at the base, and shredding, scraping, and filtering invertebrates replaced by pollution tolerant scavengers such as isopods or sowbugs (Pennak 1989). When limestone streams are dominated by such crustaceans there is concomitant decline in naturally producing trout populations (Botts 2006). In the case of Big Spring, the food web was altered further by stocking of trout including non-native rainbow or brown trout.

Non-Point Sources

The practice of winter-spreading cow manure is common in the surface watershed and along the presumed subsurface flow path between Southhampton Township and Big Spring. As noted in the hydrology section above, of all areas, limestone regions are most sensitive to non-point pollution (Veselic 2003), even with careful waste management practices. Given cultural practices of manure spreading during the dormant season when there is no crop nutrient demand, waste disposal into sinkholes, and neglect of on-lot septic systems, there is tremendous potential to concentrate non-point runoff into Big Spring and similar streams. Land Partnerships (2006) mapped vulnerability of groundwater in Cumberland County. Vulnerability to pollution in the vicinity of Big

Spring is classified as medium to high relative to the rest of the county based on DRASTIC data set of Penn State University and PADEP.

In addition to excess nutrient loading, Big Spring suffered periodic die-back of aquatic vegetation since the 1980s, attributed by Chestney (2005) to non-point entrance of agricultural or residential herbicides into the aquifer. It is also likely that use of diquat at the state hatchery contributed to reduced aquatic vegetation in the stream (Putnam et al. 2004). Additionally, failed detention basins in developed areas similarly can concentrate contaminants in conduit flow to Big Spring, as sinkholes develop due to adding water to or pumping water from the aquifer.

Water Quality Monitoring
Pennsylvania Department of Environmental Protection

Due primarily to controversy surrounding the decision to close the state fish hatchery in 2001, there has been intensive water quality monitoring on Big Spring. Pennsylvania DEP has been monitoring water chemistry above and below the hatchery culverts before and after hatchery closure. Dissolved substances such as ammonia (NH_3), toxic to aquatic organism even in small quantities, and Chemical and Biological Oxygen Demand (CBOD), elevated under high inputs of pollution, have declined substantially in the upper reaches of Big Spring since hatchery closure (Figures 9 and 10). CBOD levels of 3 or more indicate impairment. Previous studies by Black and Macri (1997)measured even higher levels of oxygen demand, likely due to differences in hatchery production and percentage of flow utilized by the hatchery. Production of the hatchery was limited during the last year of operation.

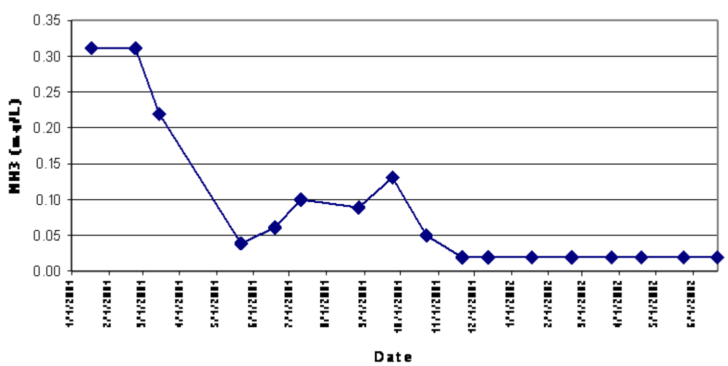


Figure 9 - Ammonia dissolved in channel water of the headwaters of Big Spring, before and after hatchery closure (Data from PA-DEP).

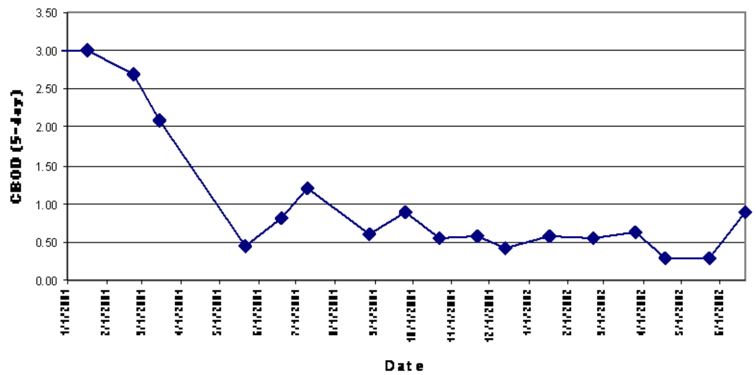


Figure 10– Oxygen Demand in the headwaters of Big Spring, before and after hatchery closure (Data from PA-DEP).

Background Fluorescence of Springs and Adjacent Wells (BSWA/Otz Hydro)

In addition to hydrologic dye tracing, the associated hydrological study has involved measuring background fluorescence of Big Spring, surrounding wells, and surrounding springs by Dr. Martin Otz, formerly of Otz Hydro Switzerland, and presently of Environmental Resource Management Inc., Dewitt, NY. This analysis has detected occasional low levels of possible animal wastes in shallow springs in Cumberland County (Mt. Rock and others) and also suggests based on similarities in organic acid content, that wells near Big Spring and most of the springs in the valley originate from the same or similar water source (i.e. a valley aquifer fed by Mountain waters rich in fulvic acids from decaying leaves).

Shippensburg University – Continued Nutrient and Turbidity Measurement

Annual nutrient monitoring near the source of Big Spring by PA-DEP and by Shippensburg University students routinely record elevated nitrate, between 5 ppm and the EPA drinking water standard of 10 ppm or mg/l. Soluble phosphorus often is elevated over 1 or even 2 mg/l. Given these background levels of nutrients coming from non-point sources, it is critical that point sources be kept low. Additionally, in limestone topography, non-point problem areas are often obvious and should be addressed directly with novel best management practices in areas where agricultural or industrial runoff drains into sinkholes or fractures. Although nitrate is elevated above natural levels in Big Spring, other nearby springs have even higher nitrate concentrations, which are correlated to increased impairment as indicated by benthic invertebrate indices of biological condition (Brookhart 2007).

Turbidity measures the degree of light scattering in a sample and so indicates sediment load in running waters. Shippensburg University students have measured low turbidity (0-7 turbidity units) in Big Spring since hatchery closure, although increases in turbidity are detectable between upstream and downstream reaches and during fall and winter (Figure 11). In contrast, turbidity was 19-29 turbidity units in Green Spring during

February 2003. Green Spring was once also a productive wild trout fishery, but now is degraded with high nutrients, turbidity, and low dissolved oxygen from aquaculture, cress farming, conventional agriculture, and other non-point impacts.

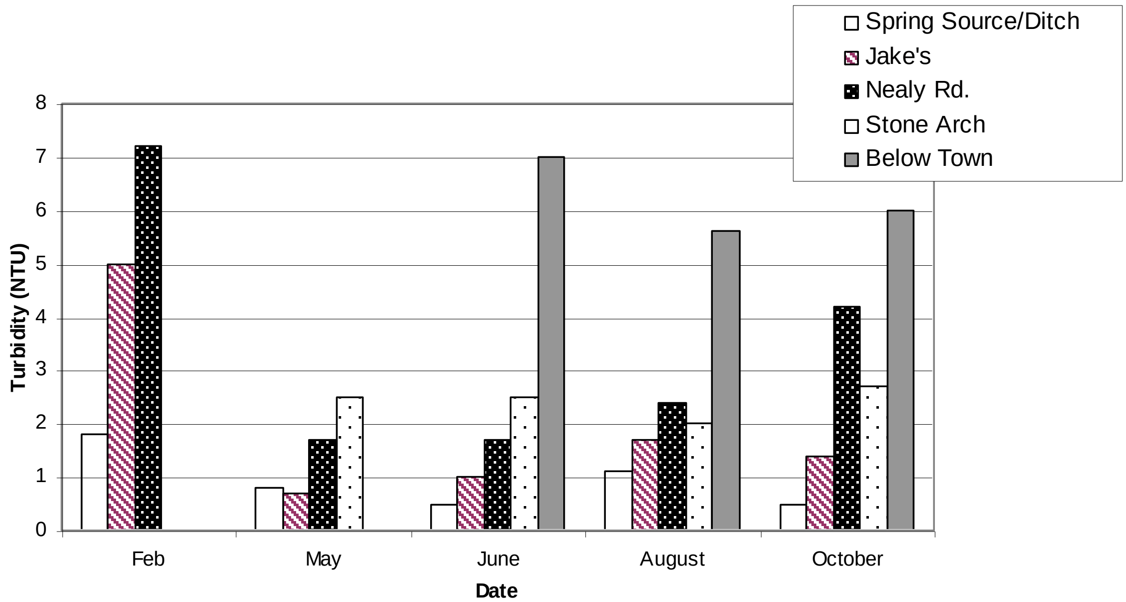


Figure 11 – Turbidity patterns in Big Spring in 2002. Sediment load generally increased downstream (left to right for each date), but is naturally very low (under 10 turbidity units –NTU).

Shippensburg University Dissolved Oxygen in Channel Water and Sediments

Predawn summer dissolved oxygen (DO) was measured by Shippensburg University faculty and student assistant (Slaven Jesic) in Big Spring, Green Spring, Falling Spring, and the Letort on hot, humid mornings of late July and early August, 2002. Predawn DO is measured at these times because photosynthesis in aquatic plants does not contribute oxygen to the water column, and so lowest seasonal and daily DO concentrations are reached. Upper Big Spring demonstrated some of the highest predawn channel water DO values measured (Figure 12), in contrast to values obtained by Black and Macri in 1990s that were below 5 ppm, the lower limit for trout. While no values this low were sampled in Big Spring in summer 2002, the DO in upper Green Spring was exceedingly low and also depressed in the lower reaches of the Letort ((Shady Lane) Figure 12). These results show that water quality during critical summer months is no longer limiting trout survival in Big Spring, but may be in other local spring creeks, even where habitat improvements have been made.

Dissolved oxygen in trout redds (spawning areas in gravel) or redd attempts was above the critical 5 ppm in winter 2002 and 2003 in seven of ten wells sampled. Three wells sampled water in slower reaches below Spring Road Bridge and at the Spring Source. These wells demonstrated levels of dissolved oxygen below 5 ppm. Fine sediments continued to lower DO in the gravel spaces in slower reaches. Even in sediments with higher DO, much gravel was embedded in sand. These results contrasted with those from

Snyder and Carline (2002), who did not find levels below 5 ppm, due likely to very low sampling effort (two devices). Since that time, Putnam et al. (2004) has noted the importance of sandy upwelling areas for brook trout spawning. It is these areas that should be assessed for future spawning substrate studies on Big Spring.

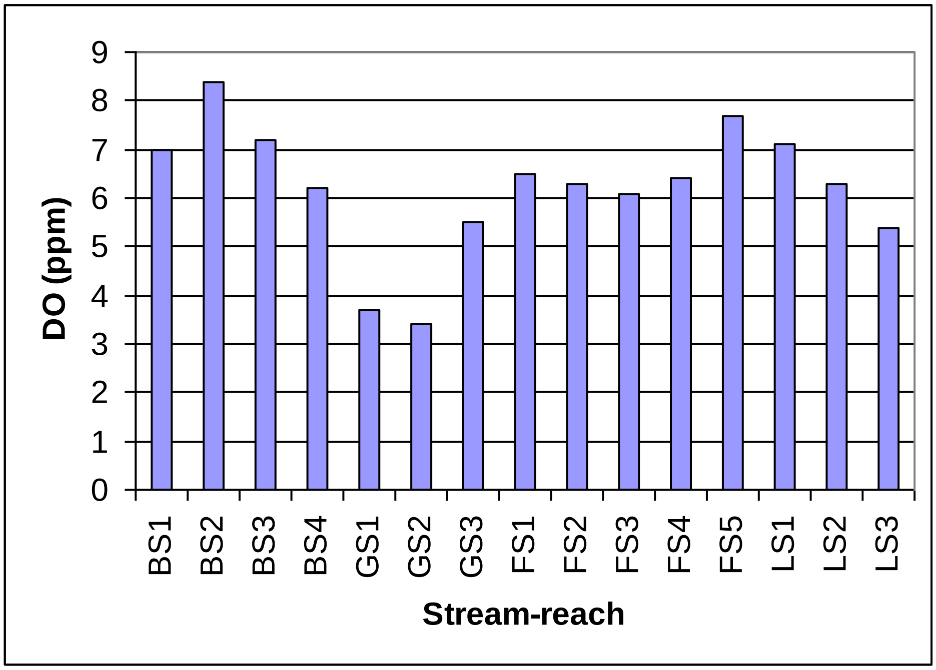


Figure 12 – Predawn dissolved oxygen in channel water of Big Spring (BS), Green Spring (GS), Falling Spring (FS) and Letort Spring (LS). Sites on each stream are ordered upstream (close to source) to downstream.

Other on-going ecological studies on Big Spring with Shippensburg students involve characterization of food webs and sediment carbon sources using non-radioactive, stable isotopes (e.g. ^{13}C), and characterization of changing aquatic plant communities through changes in resource use, restoration, and season. Isotope studies have documented that pollution tolerant sowbugs below Big Spring hatchery relied on hatchery wastes shortly after hatchery closure (Hurd et al. 2004). Recent dominant amphipods (scuds) rely strongly on algae or moss (Miller et al. 2007). Miller et al. (2007) also showed that herons and egrets on Big Spring ate primarily wild fish over stocked fish. Taken together these results indicate the need to limit particulate and nutrient discharge to spring creeks, manage stream banks to allow light to reach aquatic plants, and improve fish habitat for protection from herons (add depth and cover).

DEP, Macri, and Shippensburg University Benthic Assessments of Impairment Before and After Hatchery Closure

Water quality as inferred from benthic (stream-substrate) invertebrate monitoring is well documented for recent years on Big Spring. Initial surveys were accomplished by Eugene Macri (M.S. aquatic biology Shippensburg University), and coauthored with Dr. John Black, aquatic toxicologist (Black and Macri 1997). These authors found Big Spring dominated by pollution tolerant invertebrates during the 1990s while the PAFBC hatchery was still in operation. Mr. Macri followed up with a recent survey in 2002 that showed improvement in the stream upon hatchery closure. These results were corroborated by William Botts, water pollution biologist at PA-DEP, in repeated surveys between 1998 and 2004 that showed a general decrease in pollution tolerant crustaceans (sow bugs or cress bugs), along with recolonization by pollution sensitive taxa such as Glossosomatid caddis, a.k.a. “clean-water caddis” and Ephemeroptera (mayflies) in upper Big Spring (Tables 3-6). Additionally, the spring-semester Ecology class of Shippensburg Unversity has surveyed Big Spring and surrounding spring creeks every year since 2002, conducting surveys in January or February before any spring insect emergence has taken place. In 2005, pollution intolerant *Ephemerella* mayflies (known to fly-fishers as “sulfurs”) were found for the first time in upper reaches of Big Spring and were again found in much greater quantities in 2006 (62 in one small kick-net). This resulted in a classification of this reach of Big Spring (below the old fish barrier at the second parking lot downstream) as near reference condition, i.e. close to some of the least impaired spring creeks in the state with an indicator score of 68 (Brookhart 2007; Botts 2006). The trend of increasing Ephemerellid mayflies relative to sow bugs is correlated to improving health of Pennsylvania spring creeks (Botts 2004). The benthic community below Nealy Road still indicates impairment with dominance by sow bugs. This situation will likely change as backwater areas at crossings are cleared downstream, allowing further downstream migration of sediments.

Table 3. Invertebrate diversity as surveyed by Botts (2004) in a modified rapid bioassment of water quality in upper Big Spring (above SR 3007).

1998 To 2004, Station 1
RBP 300 Subsamples, Semi-Quantitative Macroinvertebrate Data

TAXA	MOD HBI	May-98	May-99	May-00	May-02	May-03	May-04
TURBELLERIA (Flatworms)	7	-	-	-	-	-	1
ANNELIDA (Worms, Leeches)							
Oligochaeta	10	1	4	-	1	1	-
HYDRACHNIDIA (Mites)	7	-	-	-	-	1	-
ISOPODA (Sowbugs)							
Lirceus	8	165	273	114	188	215	124
AMPHIPODA (Scuds)							
Gammarus	6	118	46	177	55	43	123
EPHEMEROPTERA (Mayflies)							
Baetis	6	-	-	-	1	5	41
TRICHOPTERA (Caddisflies)							
Glossosoma	0	1	-	-	6	7	-
Neophylax	3	-	1	-	-	-	-
DIPTERA (Midges, Flies)							
Chironomidae spp.	6	14	3	9	13	50	-
GASTROPODA (Snails)							
Physidae	8	1	2	-	-	-	9
TOTAL TAXA		6	6	3	6	7	5
TOTAL ORGANISMS		300	329	300	264	322	298
EPT		1	1	0	2	2	1

Table 4. Invertebrate diversity as surveyed by Botts (2004) in a modified rapid bioassment of water quality in middle Big Spring (Nealy Rd).

1998 To 2004, Station 2
RBP 300 Subsamples, Semi-Quantitative Macroinvertebrate Data

TAXA	MOD HBI	May-98	May-99	May-00	May-02	May-03	May-04
TURBELLARIA (Flatworms)	7	-	-	-	3	6	-
ANNELIDA (Worms, Leeches)							
Oligochaeta	10	-	-	1	2	-	1
ISOPODA (Sowbugs)							
Lirceus	8	256	230	224	224	240	160
AMPHIPODA (Scuds)							
Gammarus	6	40	63	41	79	13	97
EPHEMEROPTERA (Mayflies)							
Baetis	6	-	-	2	-	1	37
Ephemerella	1	-	1	-	2	-	1
TRICHOPTERA (Caddisflies)							
Cheumatopsyche	5	-	-	1	1	-	-
Glossosoma	0	-	-	-	1	-	-
Goera	0	-	-	-	-	2	-
Hydropsyche	4	4	-	12	6	-	3
Neophylax	3	-	-	-	-	-	3
COLEOPTERA (Beetles)							
Optioservus	4	-	-	-	-	1	-
DIPTERA (Midges, Flies)							
Chironomidae spp.	6	-	6	17	5	12	39
Simulium	6	-	-	2	-	-	7
TOTAL TAXA		3	4	8	9	7	9
TOTAL ORGANISMS		300	300	300	323	275	348
EPT		1	1	3	4	2	4

Table 5. Invertebrate diversity as surveyed by Botts (2004) in a modified rapid bioassment of water quality in lower Big Spring (below route 641 in Newville).

Big Spring Creek

1998 To 2004, Station 3

RBP 300 Subsamples, Semi-Quantitative Macroinvertebrate Data

TAXA	MOD HBI	May-98	May-99	May-02	May-03	May-04
TURBELLARIA (Flatworms)	7	-	-	3	12	-
ANNELIDA (Worms, Leeches)						
Oligochaeta	10	3	1	1	23	-
HYDRACHNIDIA (Mites)	7	-	-	-	-	1
ISOPODA (Sowbugs)						
Lirceus	8	30	53	190	252	238
AMPHIPODA (Scuds)						
Crangonyx	4	-	1	-	-	-
Gammarus	6	36	44	6	1	56
DECAPODA (Crayfish)						
Cambarus	6	-	-	-	-	1
EPHEMEROPTERA (Mayflies)						
Baetis	6	8	1	2	20	8
Ephemerella	1	72	53	9	1	4
Stenonema	3	-	3	-	-	-
TRICHOPTERA (Caddisflies)						
Cheumatopsyche	5	6	84	60	1	8
Chimarra	4	-	-	3	-	-
Hydropsyche	4	4	62	10	-	9
Hydroptila	6	-	1	-	-	-
Micrasema	2	1	-	1	-	-
COLEOPTERA (Beetles)						
Optioservus	4	5	3	8	-	12
Stenelmis	5	1	2	-	-	-
DIPTERA (Midges, Flies)						
Antocha	3	-	2	6	-	-
Chironomidae spp.	6	154	27	3	29	23
Simulium	6	7	2	4	7	-
TOTAL TAXA		12	15	14	9	10
TOTAL ORGANISMS		327	339	306	346	360
EPT		5	6	6	3	4

Table 6. Assessment of impairment in Big Spring before and after hatchery closure (from Botts 2004 - PADEP). Scores of < 46 indicated impairment in this modified rapid bioassessment protocol used by Botts for spring creeks. This threshold was later modified to 54 (Botts 2006). Site 1 is between the ditch and SR3007; Site 2 at Nealy Rd. and Site 3 below Rt. 641 (sediment is retained behind Laughlin Mill dam). Dominance by crustaceans, especially sowbugs with high tolerance to pollution, indicates lingering impairment. Of note is gradual decrease in impairment in upper reaches, and increase in impairment below.

Station	Date	Reference	Reference	Moderately	Severely
		≥69	<69-46	<46-23	<23
Big Spring Creek 1	040518			**34**	
Big Spring Creek 1	030520			**33**	
Big Spring Creek 1	020507			**30**	
Big Spring Creek 1	000509			**29**	
Big Spring Creek 1	990513				**21**
Big Spring Creek 1	980511			**31**	
Big Spring Creek 2	040518		**47**		
Big Spring Creek 2	030520			**23**	
Big Spring Creek 2	020507			**37**	
Big Spring Creek 2	000509			**32**	
Big Spring Creek 2	990513				**22**
Big Spring Creek 2	980511				**17**
Big Spring Creek 3	040518			**42**	
Big Spring Creek 3	030520			**32**	
Big Spring Creek 3	020507		**55**		
Big Spring Creek 3	990513	**81**			
Big Spring Creek 3	980511	**77**			

Maximum Score 100

Present USGS Turbidity, Temperature, and Discharge (real time)

Critical monitoring of Big Spring's water quantity and clarity is occurring on a continuous basis by a U.S. Geological Survey gauging station situated on the McCracken mill dam structure at the head of the stream. This installation monitors level, turbidity, and temperature. Discharge is estimated from a rating curve that correlates discharge with water level. This installation resulted from comments from BSWA and other concerned parties on the permit for the Pennsy Supply quarry located in the southeastern quadrant of the surface watershed. Recent data for these variables may be found online through the U.S. Geological Survey, presently at http://waterdata.usgs.gov/pa/nwis/.

PAFBC-Electrofishing Data

Trout Populations during the 1970s, 1980s, and 1990s were greatly reduced from those found by Cooper and Scherer (1967) above the Thomas hatchery (typically < 14 kg/ha – PAFBC reports – Appendix 3). Populations (numbers) of native brook trout, as well as of rainbow trout, have increased since hatchery closure, indicating a return to higher water quality.

In addition to monitoring trout populations, the PAFBC utilizes a Fish Community Index of Biological Integrity. A 2005 survey near the stone arch bridge revealed 7 species besides trout, including white sucker (122), pearl dace (112), black nose dace (17), slimy sculpin (11), four spined stickle back (10), spot fin (1), and tessellated darter (7). The four-spine stickleback (*Apeltes quadracus*) typically occurs in coastal ecosystems. It is uncertain if its occurrence in Big Spring is a unique part of its natural range, or if it was introduced as baitfish (Denoncourt et al. 1975). Other species found during the 2006 survey between the source and Nealy Rd. survey included white sucker, longnose dace, blacknose dace, pearl dace, tessellated darter, four spine stickleback and slimy sculpin.

CHAPTER 5 - BIOLOGICAL RESOURCES

Wild Trout Population Dynamics

Big Spring is gradually increasing in its upper reaches with wild, native brook trout and in its middle reaches with wild introduced rainbow trout. While this creates a diverse fishery, future thought should be given on whether or not native vs. introduced species should be encouraged, particularly through differing regulations for the two species. Recent ecological literature has pointed out that stocking of nonnative rainbow trout in coldwater streams can alter foodwebs by forcing native Dolly Varden charr (*Salvelinus malma*), a relative of the brook trout, to feed on algae-eating benthic insects rather than terrestrial insects on the surface. This in turn can increase algae populations, and reduce numbers of aquatic insects emerging from the stream (Baxter et al. 2004). It does not appear at this time that introduced brown trout will persist in the stream. However the large brown trout that have persisted are surely voracious predators on young of the other species.

Some consideration might be given also to increasing suitable spawning habitat in upwellings or near the various feeder springs. One such feeder spring the PAFBC walled off just downstream of the SR 3007 iron bridge in an attempt to narrow the stream channel in recent decades. Putnam et al. (2004) have concluded that very little physical change to the substrate has taken place since dense populations of brook trout were documented in this reach in the 1960s (Cooper and Scherer 1967), hence little physical modification is likely required. Nevertheless, moderate improvements in depth and cover may be necessary in places to optimize habitat.

PAFBC Fish Community Survey

Other fish species in the watershed include those listed above, sampled in PAFBC's annual electrofishing. In regards to the electrofishing itself, it may not be necessary to shock the same reaches every year, in an effort to maximize the number of brood fish which are generally more susceptible to injury. However, it may only take a small number of brood pairs to inundate available habitat with fry (PAFBC pers. comm.). Until recently (2005), there were very few mature brook trout in the stream below the ditch (Fig. 6). Brook trout begin pairing and preparing to spawn in early autumn. In 2004, brook trout eggs were observed on the measuring board of PAFBC during the annual sample. In 2005, two large brook trout (estimated 16-20 inches) were observed preparing a redd in the headwaters ("ditch") the day before the annual sample (Hurd – personal observation). In 2006, the PAFBC electrofished the stream in August, before spawning began. Numbers of young -of-year (50-125 mm) brook trout in the second pass relative to the first (50%) and overall recapture rate (13%) was very low. This pattern suggests either a very high population of young-of-year brook trout, or some induced mortality in this age class. This pattern was not evident for rainbow trout from the same reach (PAFBC unpublished data).

Animal Diversity

Big Spring hosts a diversity of common vertebrates along its corridor. Dominants besides fish include great blue herons, green herons, great egrets, ospreys, kingfishers, cedar wax wings and other fly catching birds, and water snakes. Caves and older trees at the source springs provide good bat habitat (James Hart, personal communication). All of these species are responding to the natural secondary production of Big Spring, i.e. high densities of fish or invertebrate prey. The Pennsylvania Breeding Bird Atlas notes presence of 72 bird species above Newville and 66 bird species below Newville, including possible or probably occurrence of species of concern such as American Black Duck, Black-Crowned Night Heron, and Northern Bobwhite. Another source (www.ebird.org) cites a total of 154 bird species on Big Spring, including bald eagle, goshawks, and a diversity of warbler species (pers. comm. -Vern Gauthier)

Reptiles and amphibians are understudied on Big Spring and other valley springs. Long-tailed salamanders thrive near limestone springs, and federally threatened bog turtles (*Glyptemys muhlenbergii*) occur in spring habitats to the east and west of Big Spring in Cumberland County, but are not reported for Big Spring.

In addition to invertebrate indicators, a unique invertebrate described only in one other historical site in Pennsylvania occurs in the headwaters of Big Spring. A Shippensburg University undergraduate working with Dr. Richard Stewart in the Biology Department has begun describing this population (personal communication - Dr. Richard L.. Stewart, Department of Biology, Shippensburg University).

The Tri-County Natural Areas Inventory update (2005) reports the following areas of concern which fall outside of the surface watershed, but likely occur within the true contributing areas of Big Spring given the results of the hydrologic dye trace. These areas are mapped in the U.S.G.S. Walnut Bottom Quadrangle by the associated alpha-numeric reference codes (Appendix 2):

> **"BURD RUN CAVES** (Southampton Twp.) **SA501a, SA501b, SA521, SA522** - Three caves located near Burd Run are home to aquatic invertebrate animal species of concern. Each of them contain a globally rare (G3) cave isopod restricted to caves in south-central Pennsylvania, and one of them also supports a globally endangered (G1G2) invertebrate which lives in pools found in limestone caves. Both of these species have very specific habitat requirements, and like other species which have adapted to life in caves, they have no eyes or pigmentation. The caves occur in an agricultural area and thus are vulnerable to leaching of pesticides or fertilizer through the soil into the groundwater. Excessive drawdown of the water table and contamination of the ground water flowing through the cave are threats to the rare species. These water caves are within one mile up-gradient of the established hydrological connection to Big Spring. This suggests the possibility that these species occur in water caves closer to the discharge point of Big Spring.

WALNUT RIDGE CAVE (North Newton Twp.) **SA528** - A G4 animal species of concern was last observed hibernating in this cave in 1989. The status of this population is unknown, and additional surveys for this species or other animal species of concern in the cave are recommended (Note – these caves may occur on the watershed divide, immediately south of Big Spring).

SPRING HILL SCHOOL GRASSLANDS -NEW-(North Newton & Southampton Twps.) **SA514 –** A breeding population of this G5, S1S2B PA-Threatened animal species of concern was observed at this site in 1984 and again in 1988. These sightings did not make it into the original NAI report. This species is common in the mid-western prairies, and with the clearing of the Pennsylvania forests for agriculture in the 18^{th} and 19^{th} centuries, had spread across the state (Brauning 1992). With the abandonment and conversion of much farmland in the latter half of the 20^{th} century, suitable habitat for this species is on the decline. This species will utilize the open, grassy habitat of pastures, fallow fields, golf courses and airports. Agricultural easements in this area would help to continue to provide suitable habitat for this species."

Game Species

Waterfowl hunting (for Canada Goose, Mallard, Black Duck, Wood duck), and trapping of small mammals (chiefly muskrat and mink) occurs along the state-owned land on upper Big Spring. Below Newville, land is posted to these consumptive activities.

Vegetation and Plant Diversity

Table 2 provides a list of some dominant plant species occurring along Big Spring Creek. Of the riparian and aquatic vegetation discussed above under "wetlands", several species are invasive and therefore of concern. These include Japanese honeysuckle, Tartarian honeysuckle, multiflora rose, tree of heaven and reed canary grass. Additionally, *Elodea canadensis* (Canadian water weed) is an aquatic invasive that strongly controls sediment dynamics within the channel (Clapsaddle 2003), *Potamageton crispus* (curly pond weed) also an aquatic invasive, dominates slow deep waters in the middle reaches, and tree of heaven is rapidly invading disturbed areas along parking areas and roadsides. Garlic mustard (*Alliaria petiolata*) is also listed in the Tri-County Natural Areas Inventory update (2005) as an important invasive in the Conodoguinet floodplain.

Aquatic plants of Great Valley Springs are listed in Table 7. Of these, watercress, water speedwell, and waterweed dominated the reach electrofished by Cooper and Scherer (1967), along with several other species. During years of hatchery operation, Big Spring was overtaken by watercress (Figure 13). Putnam (2004) suggests encouraging the return of a more diverse aquatic plant community, particularly those species that offer cover for trout, a pattern that appears to be taking place naturally on Big Spring at the present time.

Table 7. Aquatic Plants sampled from Franklin and Cumberland County Springs (Hurd and Jesic, unpublished)

Phalaris arundinacea	Reed Canary Grass
Nasturtium officinale	Water Cress
Callitriche verna	Water-starwort/Water chickweed
Ludwigia repens	Water-primrose
Najas gracillima	Bushy Pondweed
Impatiens capensis	Jewelweed
Lemna minor	Duckweed
Lemna trisulca	Duckweed
Potamageton crispus	Curly-leaved Pondweed
Veronica anagallis-aquatica	Speedwell
Hydrocotyle ranunculoides	Water Pennywort
Elodea canadensis	Waterweed
Typha latifolia	Cattail
Polygonum hydropiperoides	Smartweed
Ricciocarpus natans	
Stuckenia filiformis	Fine-leaf Pondweed

September 1997 **September 2005**

Figure 13. Water Cress Growth above and below the old Thomas hatchery in September 1997 (photos by Norman Shires), before closing of the PAFBC hatchery, and in September 2005 (photos by Todd Hurd)

CHAPTER 6 - CULTURAL RESOURCES

Arts/History/Entertainment

Newville may have grown smaller throughout the years but it is still a self-sufficient town with a full-service grocery, a pharmacy, and a well-stocked hardware store. There are two breakfast-to-lunch eateries and a fluctuating number of pizza stores. However, there are few formal entertainment options available.

One of these options is the Big Spring Area Community Center that offers fitness and craft classes and provides meeting space for different organizations. The Newville Little League Park has five baseball diamonds, a large stadium, and concession stand. At the north outskirts of the Borough is radio-controlled car racing track that regularly draws in participants from New Jersey, Maryland and West Virginia.

Newville's biggest town celebration is a yearly entertainment and craft vendor event called the Fountain Festival (named after the town's historic architectural feature). A second yearly craft show is held at the Big Spring Area Community Center. The town is also host to many lively and well-attended parades including a Halloween, Christmas, Memorial Day and Fourth of July parade. The Lion's Club Fairgrounds, located on the west side of town, regularly holds tractor and horse pulls and country/western dances. It is also the site of the Newville Fair and the Lion's Club Fair in July and August. The fairground's main building is also rented as an auction site throughout the year, and it is the location of the town's monthly volunteer recycling program. Some of the churches host a variety of classes covering fitness related concerns and general interest such as scrap-booking.

Many town residents have been living in Newville for generations and can trace their ancestry back to some of the original land settlers. As a consequence of this, the Newville Historical Society was formed in April 1966. The Historical Society is located in the Dougherty-Welch house which predates 1870. The first floor has rotating displays and the second floor is used for meetings and the Society's large genealogical and historical records. In addition, the Society hosts speakers throughout the year, takes in and catalogs donated collections, and answers letters from all over the country, mainly relating to genealogical questions. The Newville Historical Society will be a partner in the Barrel Factory Museum and will provide a display with history and artifacts of the factory, nearby McCracken Mill, and the town of Springfield.

Events are not restricted to the town center itself. The Big Spring Watershed Association has held an annual "Discovery Day along the Big Spring" each year since 2002. Discovery Day is a drive/walk educational community event held in four of the PAFBC parking lots along the Creek. BSWA partners with different organizations that each have relevance to the watershed area. For instance, one parking lot is given over to birding/nature with representatives from Audubon PA, local bird-watching organizations, and PA Master Gardeners. Another lot features scientific displays and offers audience participation of water quality tests and examination of native macro-invertebrate specimens. Other invited guests have included PAFBC, US Fish & Wildlife, Cumberland County Conservation District, Cumberland Valley Trout Unlimited, and the PA Fly Fishing Museum Inc.

The development of BSWA's Barrel Factory Museum and Big Spring Education Center would become a cultural/educational draw for residents and tourists to the Creek. The approximately 900 square feet on the first floor would contain displays on the history of Springfield, the waterway's industrial past, and the Barrel Factory itself (BSWA's partner in this area would be the Newville Historical Society). Additional features would be a library of all the scientific data collected on the Big Spring and its watershed and illustrations of the area's geology. The second floor would provide room for rotating displays or art shows and meeting rooms for other non-profit organizations. Interpretive areas will be thoroughly integrated into the building and grounds. These areas would include displays on fish habitat requirements (written board with illustrating photos or numbered points at access areas) and native vegetation (display garden surrounding the building with identified plant species and requirements) with identification of invasives. Open hours on weekends (to start) would appeal to out-of-town visitors, and BSWA events would emphasize the project and its goals to local residents. Besides the Newville Historical Society's building, this watershed area does not have another cultural/educational draw and this museum and education center would be a major asset and addition. It would help to emphasize the importance and fragility of the natural resources everyone enjoys and many times takes for granted.

Big Spring Road (SR3007), which runs along the Creek's entire length in the middle of the watershed, is utilized for charity fundraising walks and has frequently been the site of 5K runs. Because it is such a compact area--3.5 miles from town to headwaters--it is extremely accessible, and BSWA could see it utilized and developed as a cultural resource in support of new town activities, such as a Trout Festival with juried art, educational displays and vendors or a historic Turnpike walk, recreating the watershed's commerce history. Thus, any improvements made to the Big Spring area can benefit the local economy and culture base.

Recreation & Tourism

The Big Spring watershed area of Cumberland County is relatively undiscovered by the masses of tourists who regularly visit the neighboring counties. Adams County and the Gettysburg National Historic site receive millions of tourists each year and equally strong is Lancaster County with visitors to the Amish countryside. Merri Lou Schaumann of the Cumberland Valley Visitors Bureau is developing a driving tour along the Big Spring incorporating ecotourism with architectural and cultural history. The area covered by this RCP while somewhat unknown has much to offer, particularly in natural resources.

The Big Spring watershed is centered within a largely unspoiled, beautifully rural, farming-based community. It offers quiet roads to walk or bicycle upon. The Harrisburg Bicycle Club regularly rides along the Big Spring Creek and bicycling is also available on the Cumberland Valley Rails to Trails which crosses the Creek on the west side of Newville. This trail follows the old ConRail track (Map 5). In May of 1995, ConRail donated its railway corridors to Cumberland Valley Rails to Trails Council Inc., and they have been constructing roadbeds in selected areas up and down the valley since then.

Bird watching can be enjoyed along Big Spring and it is becoming a popular activity particularly in places such as the Green Ridge Retirement Village. One local town resident has spotted 120 different species along the in 2006. The Big Spring provides a place of rest and forage for migrating birds such as the Solitary Sandpiper. It also provides a winter home for the Golden Crowned Kinglet and many other bird species.

Today, fishing and hunting are the number one activities in the watershed. Area properties enroll in the PA Game Commission program to offer hunting access to private acres. Fishing is the most popular activity on Big Spring with both spin casting in mid and lower reaches, and catch and release fly fishing in the upper reaches designated EV or Exceptional Value water. It is typical to see out of state licenses on a number of cars parked along the Creek. The Pennsylvania Fish & Boat Commission maintains four large streamside parking lots approximately one mile apart, offering easy access to all ages and physical capacities. One concern is landscaping around these parking lots, which could be improved to beautify the area and prevent runoff and undesired uses by off-road vehicles.

The Rails-to-Trails trailhead center is located in Newville Borough. The trailhead parking lot allows turn-around space for horse trailers that will help bring riders onto the trail. Horseback riding is welcome but there is no buggy or carriage driving allowed on the trail. At various times, there has been a suggestion of linking the Big Spring Creek with the Rails to Trails at a second location past the Big Spring headwaters, thus allowing "loop" rides/hikes. However, since the Trail branches northwest from the Spring and is approximately two miles away from the headwaters, connection would have to be via existing roads (Map 5).

Additional recreational facilities exist at the Newville Community Park. This park offers a large jungle gym, a covered pavilion for picnics, a baseball diamond with restrooms and three tennis courts presently setup for skateboarding. The streamside area of the historic Laughlin Mill provides picnic tables and is a popular fishing location for local residents. It is also the site of many wedding and graduation photographs. The Heishman Softball Field off of SR233 provides private facilities for the area's softball leagues from as far away as Harrisburg. Informal gathering areas include the one lane stone double arch bridge that crosses the Big Spring Creek outside of the Borough.

There is a proposed pocket park near Newville that would be added once a large housing development proposed for both sides SR233 is under construction. This would offer access to this natural area, with a view up and down the Big Spring, and create a sanctuary available for bird watching, hiking and fishing. West Pennsboro Township is tentatively planning to provide a small parking area off SR233 and build a connecting trail to the Big Spring, adding additional land to the south that it hopes to acquire. The winding lane of Big Spring Road provides an unsurpassed scenic byway from the headwaters to the historic Laughlin Mill in town.

CHAPTER 7 - PUBLIC PARTICIPATION SUMMARY

A public opinion survey of residents living in the Big Spring Watershed was conducted in Spring 2006. Six hundred, two-page surveys were mailed by the Pennsylvania Environmental Council to residents using the mailing list provided by Newville Borough and Cumberland County Conservation District. In addition, BSWA mailed the survey to their membership, as well as provided about 12 additional surveys to non-responding residents who attended 2 local events in June 2006. A total of 95 surveys were returned.

Detailed survey results by question as well as summarized comments provided for each are contained in Appendix 5. The clear consensus is to protect Big Spring from development, clear silt from the sections previously mentioned, and to maintain and enhance the watershed and its unique natural and historical places for recreation and education. The natural beauty and undeveloped character of Big Spring is clearly appreciated by the public. This was especially evident in answers made by responders to question 6 (Appendix 5), in regards to what they like most, and what special places in the watershed should be recognized in the plan.

In addition to steering committee input and public feedback, Mr. Dave Miko, Area Fisheries Manager for PAFBC, provided detailed review and recommendations on the plan. Ms. Stephanie Williams, Greenspace Coordinator, and staff of Cumberland County Planning Commission, also provided valuable input and revision to the document, additional mapping, and perspectives on prioritizing goals and future activities.

Survey results confirmed that residents of Big Spring Watershed are well informed and desire the preservation and improvement of the stream and its surrounding area. Greatest concerns regarded water quality and quantity, and future development pressures. Points of concern noted were Green Ridge Village, farm chemicals, and contamination from quarrying in the watershed. The public overwhelmingly stated their appreciation of the natural beauty, clear water, and scenic/historic character, as well as the value of the stream itself as a natural resource. Fish and wildlife were also listed among what residents liked most about the stream, as well as historic places such as the barrel factory, Laughlin Mill, and Springfield. Suggested improvements were to better keep the area near the hatchery by maintaining grass riparian buffer zone and preventing excess algal growth. Many comments simply recommended preserving the stream as is by protecting the water resource and controlling development. Residents also commented on the value of the rail-trail, and the headwater area with “huge trees” and historical American Indian presence there. Others noted that improvements to the spring can help tourism and Newville’s economy, as was once the case when people used to come from out of state to fish “one of the finest streams in the country.”

CHAPTER 8 - ISSUES, RECOMMENDATIONS AND ACTION PLAN

Contributing Areas Outside the Surface Watershed-Uncertainty

A major concern of BSWA and many residents is the commercial development of warehouse/truck terminals in or right outside the watershed. With the area's karst topography and its propensity for existing or developing sinkholes, retention basin failure and resultant pollution of aquifers become a major concern. Pollution of other kinds—runoff with oils and salts, noise in the rural setting, and light from parking lots—is a problem also.

Housing development pressures are increasing in the area. At the time of this writing, West Pennsboro had given permission to a development on SR223 south of the town of Newville and in the watershed. This development will be serviced by Newville Water and Sewer, but its planned 340 homes will put pressure on the area's clean water supply. Another development next to the source of Newville Borough's water supply (Cool Spring) is being discussed. Nutrients introduced from agriculture are another threat to the water quality of Big Spring and Newville's municipal spring.

Like any area with karst (limestone) geology, groundwater flow patterns are unpredictable based on surface topography in Cumberland County, and springs such as Big Spring are derived from source water areas (recharge zones) far outside their surface watersheds. This characteristic is of paramount importance in protecting Big Spring, as hydrological traces associated with the project have recently demonstrated that rapid infiltration of runoff into sinkholes will pour into the aquifer close to Shippensburg and be carried in limestone conduits to Big Spring within 3.5 days (Figures 14 and 15). These hydrological features present the biggest challenges to protecting Big Spring, as contaminants are not filtered from runoff before entering the aquifer. More dye tracing will be necessary in the future to more clearly delineate the contributing areas of Big Spring. From work done to date, it is clear that groundwater follows the line of geologic strike between the I81 and Walnut Bottom Rd. interchange and Big Spring. Dye placed in the Yellow Breeches channel where this stream loses flow to the aquifer did not result in detection in Big Spring. Rather, this dye was detected straight-down valley at the Huntsdale hatchery springs. There are local, verbal accounts of earlier dye traces conducted from Big Pond, an iron quarry pond associated with the Yellow Breeches upstream of Walnut Bottom, with resulting connection to Big Spring. However no written documentation of this connection could be located. Monitoring wells placed by Continental Placier on behalf of Pennsy Supply Inc. indicate groundwater flow from the eastern side of Big Spring's surface watershed to be northward, toward Newville from the quarry's property on Smith Rd. and Route 11, indicating flow directly across the valley (Continental Placer 2003). Nevertheless, dye tracing indicated flow paralleling the valley, along the geological strike (Fig. 15, Map 7). This pattern is expected in karst valleys of the folded Appalachians, according to Dr. Nicholas Crawford, of the Center for Cave and Karst Studies, University of Western Kentucky (personal communication to T.M. Hurd). Following the strike-line from this quarry site within Big Spring's surface watershed suggests groundwater flow toward Mt. Rock and Alexander Spring, closer to Carlisle, although groundwater may be flowing north toward Newville. There is a pattern of smaller springs occurring on the east side of spring creeks in the valley (on the downward side of the regional gradient), such as Cool Spring of Newville, which serves as Newville's municipal supply and is north of the quarry site. As Cool Spring or Big Spring are considered for future municipal supply, it will be necessary to determine more completely the contributing areas of these springs, with particular focus on developments, quarries, or farms that generate excessive runoff and sinkhole erosion.

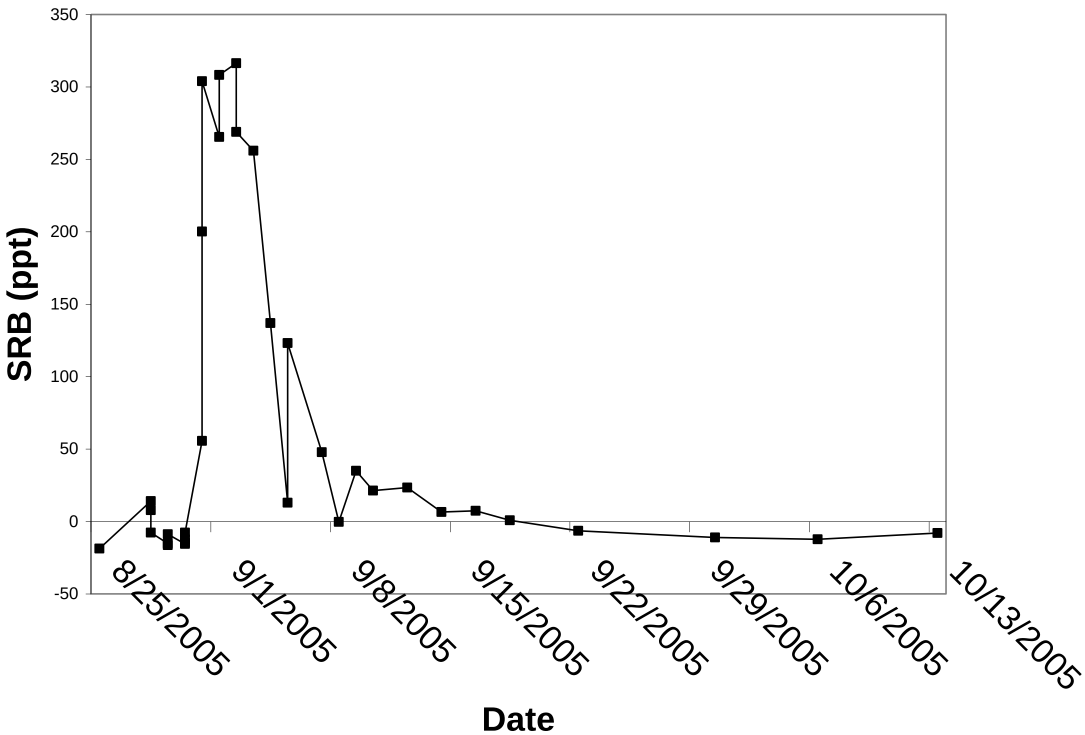


Figure 14. Breakthrough of dye (Sulforhodamine B – SRB) in parts per trillion (ppt) at the west spring, within 3.5 days from release of 1 kg of dye on August 27 into a failing detention basin 5.5 miles up-valley (Hurd et al. 2006; Brookhart 2007).

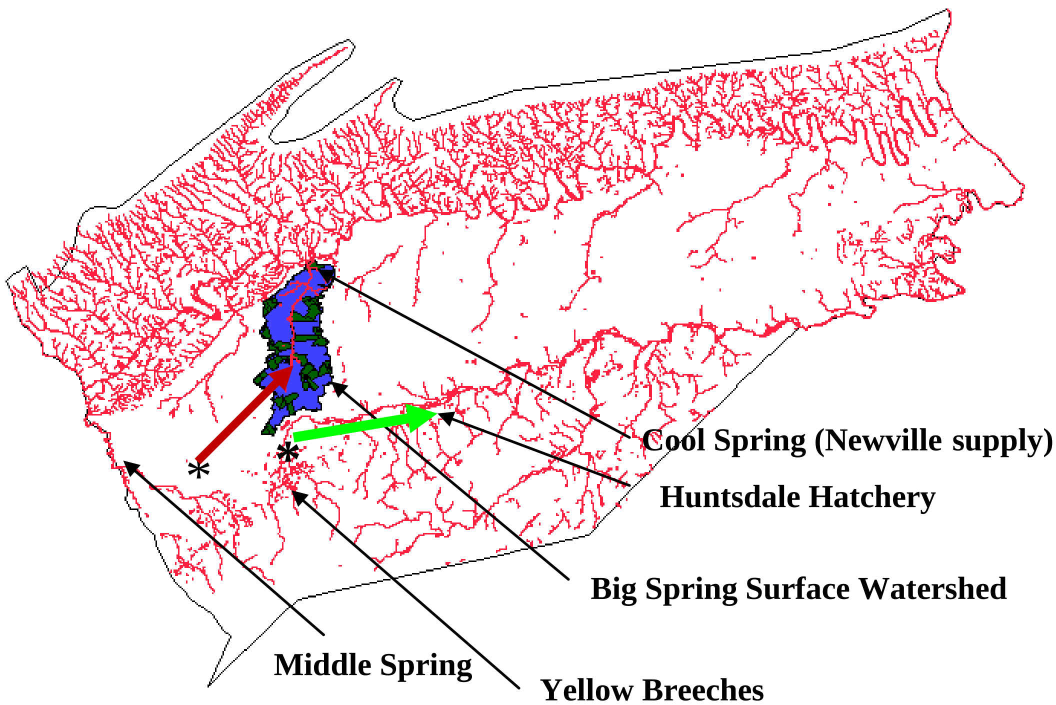


Figure 15 – Movement of tracers to Big Spring and Huntsdale Springs from release points (asterisks) in Cumberland County, Pennsylvania. Green Spring and Bullshead Branch to the west, and Cool Spring, Mt. Rock Spring, and Alexander Spring to the east were also monitored, but no dye was detected (Hurd et al. 2006; Brookhart 2007).

State Fish Hatchery Culverts

The PAFBC fish culture station operated between 1972 and November, 2001. A benthic invertebrate and chemistry study conducted by Dr. John Black and Gene Macri, M.S. in aquatic Biology, indicated impairment of Big Spring (Black and Macri 1997). Benthic studies conducted by Bill Botts, water pollution biologist, PA-DEP, corroborated these results. While closure of the hatchery by PAFBC has resulted in improvements in the biological health of the stream, one of the two culverts (north-most) channels local runoff to the stream's headwaters. In one rain event in 2005, this resulted in substantial sediment loading to the stream via this hatchery culvert (Figure 16). BSWA would like to work with PAFBC to mitigate this problem. Other raceways exist at the old Thomas hatchery site further downstream on the West side of the stream. These are in ruins and covered with successional forest, but should be examined further to determine if they contribute siltation to Big Spring through outlet pipes, or serve as habitat to wetland organisms.

Figure 16 – Sediment-laden discharge (February 2005) from one of the two hatchery/roadside culverts that serves as a conduit from up-slope agricultural land and impervious surface. Continued nutrient loading via the other culvert is also suggested by algae in the right-hand side of the photograph (Photo – Jean Coates).

Direct Runoff into Aquifer via Sinkholes (Concentrated Non-Point Pollution)

The west spring of Big Spring is susceptible to sedimentation during strong rain events. This spring is connected to at least one large sinkhole that ironically occurs in a failing detention basin engineered to slow runoff from an impervious surface (Figure 17). A second failing detention basin has occurred at the Pennsy Quarry site within the surface watershed. In this sinkhole drainage, turbid water was observed to enter directly into the aquifer rather than percolate through the system of drainage pipes and rock-fill.

Figure 17- A failing detention basin draining runoff from impervious surface directly into the aquifer via a sinkhole. Dye from this site, far outside the surface watershed, traveled 5.5 miles to Big Spring within 3.5 days (photo T.M. Hurd).

Figure 18 – Clear East Spring (background), and turbid west spring (foreground) of Big Spring following a rain event of over 4 inches on July 12, 2004. Photograph T.M. Hurd

Quarrying

Limestone quarrying is expanding in the Cumberland Valley, with one recently permitted quarry within the surface watershed near Rt. 11 and Smith Rd. While this quarry is permitted to blast to sea-level (a depth of about 600 feet), the permit conditions require approval from PA-DEP to continue with each 50' increase in depth beyond the water table. In order to detect potential quarrying effects and take corrective action should blasting interrupt conduit flow or increase turbidity of the source springs approximately 1.3 miles away, the United States Geological Survey is monitoring stream level, flow, turbidity, and temperature on Big Spring as a condition of this permit. Groundwater models applied during the permit process had low predictive ability for limestone aquifers. Well data from the quarry site, while reported to show northward flow of groundwater, are based on low-yielding, shallow wells that may be disconnected from larger, regional flow paths. Given the position of this quarry on the down-gradient side of the regional flow pattern (northeast surface watershed), any likely influence to Big Spring would likely occur on the smaller east contributing source springs or to Cool Spring, another east-contributing source spring that is utilized for public water supply by the Borough of Newville.

Chestney (1997; 2005) makes historical reference to effects of clay-quarrying activity that muddied the waters of Big Spring, particularly during the early 1900s. Chestney also noted that one of the source springs continued to run clear during such events. This pattern was observed during a strong summer rain event in 2004 (Figure 18), suggesting along with the dye trace that east and west source springs differ in water sources and flow paths. There is current evidence that the historic quarry, cited by Chestney (1997; 2005) and within seven tenths of a mile from Big Spring, continues to introduce soil to the aquifer, (Figure 19).

Figure 19 – Abandoned quarry 0.7 miles from the source of Big Spring, with soil erosion into a fracture. This site was implicated in increasing the turbidity of Big Spring in the early 1900s (Chestney 1997).

Use of Big Spring for Water Supply

The Borough of Newville currently draws water from Cool Spring, and is seeking to take additional surface water from the main channel of Big Spring at Cool Spring (personal communication-Robert Pody of the Susquehanna River Basin Commission). Given Big Spring's continued down-stream recovery of a wild trout fishery, sediment buildup behind the Laughlin Mill dam at the proposed point of intake, and potential for rapid contaminant transport to these springs, it may not be ideal to increase reliance on spring water. On the other hand, if limited quantities are drawn from Big Spring, sediment is removed, and water quality protected, this part of the stream could become a much greater recreational and consumptive resource.

Silt Behind Bridges and Mill Dam

There is a build-up of "legacy sediment", i.e. sediment from past agriculture (Clapsaddle 2003) and fish hatcheries (Hurd et al. 2004), particularly behind downstream-structures such as the Rt. 233 bridge, and Laughlin Mill dam. The chemical composition of this sediment should be determined in order to discern past sources and present potential for toxicity. The sediment should be removed from the channel in order to facilitate recreational or consumptive use of the water resource.

Development Pressures on Wastewater Treatment

The largest, current point-source discharge into Big Spring occurs from the Newville wastewater treatment plant. While the facility has adequately treated existing wastewater, with large developments being proposed and built in the area there is less capacity than potential future demand. Biological indicators of water quality also suggest water quality is declining in the vicinity of the wastewater plant (Botts 2004 – see above). Given the high nutrient levels of Big Spring as it discharges from the regional aquifer, it will be important to continue to limit discharge of additional nutrients and organic matter from wastewater treatment with updates to the plant.

Greenway Development/Public Access

A major goal of BSWA is development of a Big Spring Greenway in order to insure public access for fishing and other recreation. Given PAFBC ownership of most of the first half of the stream, and the relatively undeveloped character of the stream below Newville, there is good opportunity to secure future, public enjoyment of Big Spring. Already there have been attempts by private clubs to buy land along the lower reaches near the Conodoguinet, something BSWA opposes due to associated restriction of access by non-resident enterprises.

Upon completion of this plan, BSWA plans to pursue a green way development that enhances public access and recreational opportunities on Big Spring, while also fully addressing concerns of landowners along the spring. Because much of the corridor is owned by the public (PAFBC or Borough of Newville), there is good probability of success for this effort. Moreover, the Big Spring corridor is listed as a major "conceptual greenway," one of 10 in the county noted for regional significance, along with Doubling Gap Creek, another tributary of the Conodoguinet in close proximity to Big Spring. A minor greenway is mapped to the south of Big Spring, connecting it with the upper Yellow Breeches along Big Spring Road, Rt. 11, and Stoughstown Road (Land Partnerships 2006).

Ecotourism, Emphasizing a Wild Trout Fishery

Newville Borough and the surrounding townships have in Big Spring a potential economic as well as ecologic jewel of the Cumberland Valley. The fishery has already been restored to the point of attracting many to fish for wild fish throughout the upper and middle reaches. Total public use for fishing was apparently greater during hatchery operation than the present (PAFBC – pers. comm.). Nevertheless fishing was concentrated at the ditch or headwaters for large fish of hatchery origin. This occurred at the expense of wild trout throughout the stream, and it has taken a number of years since 2001 for trout populations to increase due to low numbers of brood fish (Figs 5 and 6). Therefore, both the fish population and the fishing/guiding has increased slowly based on existing stocks of brook and rainbow trout. If water quality and quantity is protected, along with public access, and habitat is improved, fish populations should increase rapidly and local businesses should benefit. Spring creeks are unique ecosystems that are sensitive to wading and boating in regard to stream substrate, bank stability and erosion, aquatic plant life, and benthic communities. The fishery has tremendous potential to offer trophy wild trout. In light of these characteristics, recreational development should be done in a sustainable fashion encouraging light impact activities, and regulations protecting wild fish. Boating, if allowed at all, should be limited to the lower reaches below Newville, and possibly to the mill pond in Newville once accumulated sediment is removed.

Expansion of Exceptional Value/High Quality Waters Designation and Catch and Release Waters for Trophy Trout.

The exponential increase in wild brook and rainbow trout, and increases in pollution-intolerant invertebrates should facilitate re-designation of most of the upper and and mid reaches of Big Spring to class A, High Quality status in the near future. Extension of Exceptional Value status for some of the upper reaches may also be possible. BSWA will aggressively pursue this re-designation in order to provide maximum protection to the stream.

Continued habitat modification, following the advice of Clapsaddle (2003) and Putnam et al. (2004) to create habitat improvements upstream and remove sediment downstream, should facilitate the downstream expansion of High Quality, Class A water designation, as trout populations continue to increase and invertebrate populations increase and diversify. Species specific creel size and limits, as well as more active management (trap and transfer of rainbow trout), might allow brook trout to repopulate more of the stream and compete successfully with rainbow trout. Nevertheless maintained water quality and improved habitat are likely most important for fostering brook trout recovery.

BSWA is committed to wild, native brook trout restoration in Big Spring. This commitment has been in BSWA's mission statement since inception, and is consistent with current fisheries management initiatives (e.g. Eastern Brook Trout Joint Venture of the National Fish Habitat Action Plan (http://www.fishhabitat.org/action.htm). Also, the Letort Spring in Carlisle offers a wild brown trout fishery, and Falling Spring in Chambersburg a wild rainbow trout fishery. Restoration of Big Spring to its historical status of a wild brook trout fishery would best complement these nearby fisheries.

Cohesive/Multi-Municipal Planning

Like many regions in Pennsylvania, the area surrounding Big Spring would benefit from cohesive, multi-municipal planning. As the valley develops, municipalities will need to plan jointly in order to provide adequate supplies of clean drinking water and sewage treatment and to prevent contamination of karst springs by confined animal feeding operations, quarries, the I81 and I76 corridors, up-gradient sewage treatment plants, and associated activities and development. Of particular issue is inadequate storm water and agricultural runoff management as evidenced by failing detention basins, infiltration galleries, and manure management plans. The Cumberland County Planning Commission is initiating a countywide storm water management study under the guidelines of the Pennsylvania Stormwater Management Act (Act 167) and will be funded by PADEP and Cumberland County. Phase one of the plan should take into account the aforementioned and newly identified stormwater problems. Phase two of the management plan will be the development of a countywide storm water management plan and model ordinances. As related to water resources, this regional focus is particularly critical in limestone areas due to their unique hydrology and lack of ability to filter contaminants.

In addition to the municipalities within the surface watershed of Big Spring, municipalities within the likely contributing area of Big Spring also include Southampton Township and Shippensburg Township. County comprehensive, storm water management, and green space plans should be referenced in order to facilitate joint planning that protects Big Spring, other springs, and the connected valley aquifer. Specific goals for farmland preservation and smart growth, combined with implementation of best management practices for agricultural and storm water runoff will aid in protection of the aquifer (Land Partnerships 2006). More specifically, source area protection programs for springs should be implemented which recognize hydrogeological over municipal boundaries. In karst valleys of the broader Appalachian region, these patterns typically reflect infiltration along geologic dip and through karst features such as sinkholes and sinking streams, with regional conduit flow occurring below the water table along geologic strike (Ginsberg and Palmer 2002). Dye traces should be required from industrial development zones to area springs, given susceptibility of the aquifer to pollution.

River Registry and Scenic River Designation

Big Spring's pastoral environment, and restored historical structures, colorful wild trout, and gin-clear waters with constant plant growth make it one of the more beautiful streams in Pennsylvania. Several historic structures occur along its length, including a restored grist mill in Newville, a barrel factory at the source that is currently being renovated by BSWA, and the historic village of Springfield just above the spring's headwaters. These features make Big Spring an excellent candidate for official Scenic River designation and for the River Registry designation of the corridor.

Handicapped fishing Area

BSWA is very interested in working with municipalities and the Green Ridge Village Retirement Community to facilitate handicapped fishing along Big Spring. The logical location for this to begin would be near Green Ridge, where Big Spring is also currently stocked with adult brook trout by PAFBC. BSWA envisions eventual creation of handicapped access to major fishing reaches on the stream, as opposed to more limited points along the stream.

Bed and Breakfasts and Restaurants of Character

It is critical that Big Spring maintain its scenic beauty and Newville its historical character. Therefore, development of a service industry fitting for eco-tourism and fishing is encouraged, but not at the expense of the watershed's rural character. The present Bed and Breakfast in Stoughstown, operating within one of the area's many historic structures, and revitalization efforts within the Borough of Newville are exemplary for how future development should proceed.

Fish Habitat Restoration

Rivers Unlimited Assessment and PAFBC/USFW Restoration Efforts

Clapsaddle (2003) noted that recommendations for each study reach (Appendix 4) are based on the goal of restoring the stream to best possible brook trout habitat, and "that it is reasonable to think that Big Spring could once again become one of the best brook trout fisheries on the East Coast." General recommendations were to narrow specific sections of the stream channel, but with the caution that this approach should only be applied to very wide sections of the channel. He recommended use of existing features and some rock cover to encourage growth of water cress (or other aquatic vegetation) in order to create natural channel narrowing. Putnam et al. (2004) also emphasized use of vegetation and conservative manipulation of the channel. Where manipulation is appropriate, Clapsaddle (2003) recommends large pieces of limestone and some woody material to create a matrix that will promote healthy and stable riparian area. Also in his general recommendations, Clapsaddle (2003) recommends changes to in-stream structure to improve the way the stream fishes, with particular focus on removal of sediment in reaches between the mid-reaches and Newville. This legacy sediment has accumulated behind each bridge (Nealy Rd, Stone Arch, Rail culvert, and State Rt. 233), as well as behind the Laughlin Mill dam. At time of this writing, the double culvert at Nealy Road has been replaced by a single span bridge. This change should continue to move sediment downstream as well as decrease ponding above Nealy Road. Clapsaddle notes that one of largest priority tasks is sediment removal in order to renovate the streambed. This action is recommended from his reach 5 (the third Parking area downstream, above Nealy Road) downstream to the Lauglin Mill dam. At time of this writing, the Borough of Newville is considering a project to remove sediment behind this mill dam in order to facilitate drinking water removal from the channel near Cool Spring, and to improve the pond for recreation and for the sake of adjacent property owners (Fred Potzer Newville Borough Manager). For upstream reaches, Clapsaddle (2003) recommends use of a suction dredge, with note that issues of nutrients and contamination should be considered if the materials dredged are used on restoration sites. Nevertheless, recent high flows have moved much of the sediments observed by Clapsaddle (2003) downstream to the vicinity of the Rt 233 bridge and Laughlin Mill pond within Newville.

Perhaps of greatest import, Clapsaddle notes that "strict adherences to common principles used in the natural design process are not necessarily applicable for the Big Spring." Dave Putnam of U.S. Fish and Wildlife notes that Big Spring might be managed as a large "pond" (personal communication to T.M. Hurd), similar to sandy, northern ponds where brook trout thrive. Putnam et al. (2004) note that the sediment fractions included only 3-8% fines, i.e. they were not as clogged with silt and fine sediment as expected, and sand accounted for 48% of the stream bed sediments. Upon comparison with other central Pennsylvania Spring Creeks, this characteristic was found to be common, suggesting that aggressive modification of sediment fraction with gravel was not necessary to support spawning of native brook trout, as this species spawns successfully in sandy substrates of northern lakes where brown trout do not. In short, Putnam et al. recommend a "minimalist approach to restoration" and conclude that in the upper reaches, the existing substrates are what the original world-class brook trout fishery used for spawning. These authors do recommend that several of the existing man-made structures (especially wingwalls) be modified to improve stream function and appearance. In agreement with Clapsaddle (2003), Putnam et al. (2004) note that "downstream much more aggressive measures will be required to remove the silt slug that is continuing to move through the system"

Clapsaddle (2003) recommends maintaining native riparian vegetation that provides deep, dense rooting structure, with avoidance of large deciduous or coniferous trees as such vegetation tends to actually promote erosion of unstable riparian soil. Specific recommendations also include the eradication of multiflora rose. The authors of this plan would add to this the eradication of other invasive, non-native plants, especially tree of heaven (*Ailanthus*).

In his analysis, Clapsaddle (2003) broke Big Spring into 12 sample reaches (Appendix 4). His specific recommendations for restoration in each reach may be viewed in his project report, available electronically from Big Spring Watershed Association or Cumberland Valley Trout Unlimited upon request.

Of greatest importance in restoration is complete restoration of water quality, with particular focus on prevention of hatchery and roadside infrastructure from conducting sediment or nutrient-laden runoff of any kind into Big Spring, and providing necessary upgrades to wastewater treatment in Newville. Once source areas are better delineated (see section below), non-point pollution may also be better mitigated by repairing or buffering sinkholes draining runoff from agricultural or developed landscape, and implementing other best management practices for agriculture, storm water basins, and infiltration galleries.

Prevention of Additional Point and Non-Point Pollution

The fluorescent dye trace (FDT) project that served as a funding match to this project provided valuable information regarding contributing area of Big Spring and susceptibility to contamination. The following conclusions and recommendations from the final project report and Hurd et al. (2006) should provide municipalities, agencies, and other planning boards critical information for protecting Big Spring and Cool Spring into the future.

Regional groundwater flow patterns followed the valley along geologic strike (bedding planes of rock formations) based on highest certainty dye trace results from the Crawford Hydrology Lab (2004). The trace was conducted according to protocols of the Crawford Hydrology Lab (2004) and Otz et al. (2004). The documented pattern of flow is nearly perpendicular to flow-direction estimated from quarry wells and models within the surface watershed of Big Spring (Continental Placer 2003). Moreover, regional flow determined from the dye trace occurs at linear velocities 500-4000 times greater than hydraulic conductivities determined by pump tests in the quarry wells. This discrepancy demonstrated the value of fluorescent dye traces to properly understand and protect water resources in limestone aquifers.

Partial contributing areas for Big Spring and springs at Huntsdale are located far up-valley, and in the case of Big Spring, indicate rapid inter-basin flow from near the Burd Run/Middle Spring watershed near the Shippensburg/Southampton township line. Surface runoff in this area directly enters the groundwater system, originating in zones of development (trucking warehouses, residential, and business) and from a drainage system open to highway spills near the Rt. 81 and 174 interchange. Further dye-tracing from this area with monitoring of additional springs would be valuable to better characterize regional groundwater flow patterns in the valley, as preliminary estimates suggest $< 10\%$ of dye released at this point was recovered in Big Spring. Additionally, best management practices in storm water drainage should be used in this area given the patterns of land use and known rapid transport to Big Spring.

West and east sources of Big Spring are connected, however conduit flow occurs only to the West source from the above-mentioned area. The east spring exhibits more diffuse flow character, and likely has a different contributing area from that of the west spring. Its source should be investigated by a fluorescent dye trace from release points closer to, or on the east side of the surface watershed of Big Spring, including the Pennsy Quarry site.

The municipal spring of Newville's water supply (Cool Spring) that flows into Big Spring 5 km north of the headwaters apparently belongs to a separate flow system (no dyes were detected). Source areas should be determined by fluorescent dye tracing if use of this spring is continued or expanded. Potential dye release points are on the east side of the Big Spring surface watershed, including the Pennsy Quarry site, and on the northwest side of the Big Spring surface watershed if groundwater is following geologic strike and passing beneath the Big Spring channel. Additional fluorescent dye traces directly from the upper Big Spring channel to Cool Spring should also be conducted to determine with certainty that the supply spring is not susceptible to contamination that is rapidly transported to Big Spring.

Dye was not detected in Cool Spring, Green Spring, Bullshead Branch, Mt. Rock Spring, or Alexander Spring, indicating that these are either separate flow systems (parallel bands within the valley), that connection exists in a regional aquifer further up-gradient than dyes were released in this study, or that greater quantities of dye than used in this initial study may be necessary to trace regional, shared, source waters.

The upper Yellow Breeches does not appear to contribute to Big Spring or other spring creeks studied. Flow from this release site was slower toward springs adjacent to the Yellow Breeches 9.5 km down-gradient at Huntsdale Hatchery. It is possible that different amounts of dye placed at other injection locations and a longer study could demonstrate inter-basin flow from the Yellow Breeches to north-flowing spring creeks in the valley center, particularly those further to the east (e.g. Letort Spring). However no positive connections were demonstrated for the springs monitored in the present study. A future FDT could be done from the higher, losing tributaries of the Yellow Breeches and Middle Spring, or perhaps from iron ore pits that exist in the vicinity of these tributaries to avoid the chances of slowing or losing the dye in South Mountain colluvium.

In regards to the Pennsy Supply Quarry, recently permitted in 2004 within the surface watershed of Big Spring, FDTs should be conducted from the highest yielding (supply) well on the site and from sinkhole collapses in infiltration galleries to determine which springs may be regionally connected and potentially influenced. Such springs might include Big Spring (particularly the East source), Newville Municipal supply and springs down-valley toward Carlisle (Mt. Rock, Alexander Spring, and the Letort).

Based on Continental Placer's Quarrry Dewatering Impact Evaluation, which included only a limited number of well data and models that assumed no fracture or conduit flow, groundwater was suggested to flow north from the quarry site, with hydraulic conductivities of only 1-2 feet per day (Continental Placer 2003). However, both fluorescent dyes used in this study showed that groundwater moved to the east and north through the same limestone formation up-valley, at velocities of 0.3 – 3.0 km per day. It is surprising that the mining division of PA-DEP was satisfied with the hydrological models to grant the quarry permit. This study has demonstrated the need for dye tracing to accurately characterize, and thus protect groundwater resources in this and other limestone valleys. Karst characteristics and FDT techniques are very well known (Käss 1998, Crawford Hydrology Lab, Häuselmann et al. 2003, Veselic 2003; Otz et al. 2004), and PADEP divisions and municipalities should work closely together and aggressively to protect groundwater resources and karst springs based on the appropriate application of hydrological techniques.

Infiltration galleries in the region can fail with sinkhole collapse (Feeney, T. pers. comm.; Ralston. and Oweis 1999) and so should be closely monitored by PA-DEP at the Pennsy quarry and asphalt production facility. Indeed a sinkhole collapse has occurred and has already needed repair in an infiltration gallery of the quarry from stormwater runoff (PADEP Mining Inspector Jack Thorton – pers. comm.). This has demonstrated susceptibility of the aquifer to runoff even before groundwater is pumped from the quarry. A fluorescent dye-trace should be conducted from this sinkhole in the near future if it re-opens, particularly before mining occurs to the water table. This study has demonstrated that cost-effective fluorescent dye tracing can be done successfully using low quantities of dyes that pose no harm to ecological health or to public health and perception. In addition, the technique provides irrefutable results for source water delineation and protection.

Preliminary background fluorescence analysis suggests low levels of contamination for the time period sampled, with very similar source waters between springs, and between springs and wells along Big Spring. Organic acid peaks are similar to uncontaminated waters of South Mountain tributaries in nearly all samples. A 1-2 year study should be conducted for springs that evidence impairment based on nutrient loads, algal blooms, and pollution tolerant invertebrates using this technique in order to further define primary sources of organic loadings (Dr. Martin Otz – pers. comm.)

Demonstrated regional conduit flow to Big Spring shows the potential for springs to be rapidly and significantly contaminated by surface runoff via sinkholes in storm water basins, infiltration galleries, and agricultural settings. This pattern has also been recently recognized by additional research in the region (Lindsey et al. 2006). Regional planning and better source water protection strategies (e.g Kacaroglu 1999) that take into account these flow patterns and velocities need to be established soon if the quality and quantity of water to Big Spring, and similar springs in the region are to be maintained .

Detailed Management Priorities Based On Steering Committee Feedback

Appendix 6 lists the detailed recommendations of the steering committee. Recommendations were prioritized on a scale from 1 to 3 with a score of 1 indicating highest priority and averaged across committee responses. Highest priorities from Appendix 6 (scores of 1-1.5) are listed below. Associated partners and implementation strategies are listed with recommendations in Appendix 6.

Priority Recommendations

- Mitigate development and aquifer pressures through changes in zoning and updated regional planning
- Create a regional Environmental Advisory Council
- Coordinate with Cumberland County and Tri-County Regional Planning Commissions
- Continue regional planning and planning implementation efforts within watershed
- Identify and Control non-point nutrient and chemical pollution from agricultural and human sources
- Reduce direct runoff of surface pollutants into limestone aquifers via sinkholes
- Explore options to mitigate sinkholes
- Mitigate stormwater surface runoff
- Mitigate potential damage to conduits as Pennsy quarry operations deepen
- Upgrade public sewage treatment discharges as per DEP regulations
- Protect primary and secondary regional water sources, i.e. Cool Spring (Newville water supply)
- Reclassify water quality designation and fishing regulations to reflect and protect the wild trout population, especially native brook trout
- Mitigate siltation/turbidity of Big Spring
- Limit use of herbicides near hatchery/source springs
- Develop a restoration and reuse plan for Barrel Factory, with potential conversion to a museum
- Develop and maintain fishing access for all, including elderly and disabled
- Develop Rails to Trails connection (linking trail and stream recreation at the crossing, and improving culvert condition).
- Establish a comprehensive stream and plan monitoring program.
- Pursue River Registry Status

Most other management activities listed scored at least a 2, indicating the overall importance the committee placed on nearly all management options, most of which were well aligned with priorities of the surveyed public.

In summary, Big Spring arises from unique limestone geology and hydrology sensitive to pollution, and creates a unique natural environment that has also been and continues to be used as an important water resource. Management therefore requires a deliberate consideration of what is known and unique about the resource. This River Conservation Plan is but an initial step taken by BSWA and other stakeholders in gathering this knowledge and prioritizing for the future. Continued, cooperative work among BSWA, municipal boards and councils, county and state agencies, universities, and non-profit organizations beyond the surface watershed boundary will be required in order to maintain and improve the quality of Big Spring, its water, and resulting natural and human environment. As a “priceless, natural resource” (Shires 1997), Big Spring deserves nothing less.

BIBLIOGRAPHY

Baxter, C.V., Fausch, K.D., Masashi, M., and P.L. Chapman. 2004. Fish invasion restructures stream and forest food webs by interrupting reciprocal prey subsidies. Ecology 85(10): 2656-2663.

Becher, A. and S. Root. 1981. Groundwater and Geology of the Cumberland Valley, Cumberland County, Pennsylvania. Water Resources Report #50 DER of Pennsylvania.

Black, J.J. and E.P. Macri Jr. 1997. An ecological survey of Big Spring Creek with emphasis on the effects of fish hatchery effluent.

Boaventura, R., A. M. Pedro, J. Coimbra, and E. Lencastre, E. 1997. Trout farm effluents: characterization and impact on receiving streams. Environmental Pollution 95:379-387.

Botts, W. F. 2004. Aquatic biological investigation Big Spring Creek, Cumberland County. Commmonwealth of Pennsylvania Department of Environmental Protection, South-Central region, Water Management Program, Internal Report, October 19, 2004, Stream File 2.21.0, Stream Code 10378. Harrisburg, Pennsylvania, USA.

Botts, W.F. 2006. An Index of Biological Integrity for “True” Limestone Streams. Commonwealth of Pennsylvania Department of Environmental Protection, Southcentral Regional Office, 909 Elmerton Ave., Harrisburg, PA 17110.

Brannaka, L. 2003. Precipitation, Maximum Temperature, Minimum Temperature, Stream Level, and Groundwater Level Data Plot from 1991 to 2003. Unpublished Data.

Brauning, D.W. (ed.). 1992. Atlas of Breeding Birds in Pennsylvania Univ. of Pittsburgh Press, Pittsburgh, PA. 484.

Brookhart, A.D. 2007. Benthic Assessment of water quality and fluorescent tracing of contributing areas to karst springs in the Great Valley of Pennsylvania. Masters Thesis. Shippensburg University Department of Biology. Thesis advisor T.M. Hurd

Camargo, J. A. 1992. Structural and trophic alterations in macrobenthic communities downstream from a fish farm outlet. Hydrobiologia **242**:41-49.

Carline, R.F. 1980. Features of successful spawning site development for brook trout in Wisconsin ponds. Transactions of the American Fisheries Society 109:433-437.

Carline, R. F., P. M. Barry, and H. G. Ketola. 2004. Dietary Uptake of Polychlorinated Biphenyls (PCBs) by Rainbow Trout. North American Journal of Aquiculture **66**:91-99.

Chestney, J. 1997. The washtub trout p 278-283 *In* Limestone Legends: papers and recollections of the Fly Fishers' Club of Harrisburg 1947-1997. Compiled by Norm Shires and Jim Gilford. Stackpole Books, Mechanicsburg, PA.

Chestney, J. (2005). The Saga of Big Spring Creek: a chronological study of the stream and its problems. Paper presented to the Fly-Fishers of Harrisburg annual luncheon, April 2005.

Chichester, D. C. 1996. Hydrogeology of, and simulation of ground-water flow in, a mantled carbonate-rock system, Cumberland Valley, Pennsylvania. U.S. Geological Survey Water Resources Investigations Report 94-4094. Lemoyne, Pennsylvania, USA.

Clapsaddle, C. 2003. Big Spring Geographic Assessment. Prepared for Cumberland Valley Trout Unlimited, Chapter No. 052. Rivers Unlimited Inc.

Continental Placer. 2003. Quarry Dewatering Impact Evaluation. Produced for Pennsy Supply Inc., Penn Township Operation, Penn Township, Pennsylvania. PA December 2003.

Cooper, E. L., and R. C. Scherer. 1967. Annual production of brook trout (*Salvelinus fontinalis*) in fertile and infertile streams of Pennsylvania. Paper number 3217, Journal Series of the Pennsylvania Agricultural Experiment Station. Proceedings of the Pennsylvania Academy of Science **41**:65-70.

Crawford Hydrology Lab. 2004. Laboratory Profile. Center for Cave and Karst Studies Applied Research and Technology Program of Distinction Department of Geography and Geology. Crawford and Associates, Inc. Bowling Green, Kentucky.

Denoncourt, R. F., C. H. Hocutt, and J. R. Stauffer, Jr. 1975c. Additions to the Pennsylvania ichthyofauna of the Susquehanna River drainage. Proceedings of the Academy of Natural Sciences of Philadelphia 127(9):67-69.

Dunn, T. and Leopold, L. 1978. Water in Environmental Planning. New York, NY. W.H. Freeman and Company, 818 pp.

Embeck, M. S. 2000 a. Polychlorinated Biphenyl (PCB) Investigation, PFBC Fish Culture Station, Big Spring Creek, North Newton Township, Cumberland County. Commonwealth of Pennsylvania Department of Environmental Protection, Internal Report, June 22, 2000. Stream File 2.21.0, Stream Code: 10378. Harrisburg, Pennsylvania, USA.

Embeck, M. S. 2000 b. Water Quality, Dissolved Oxygen and Sediment Investigation PFBC Big Spring Fish Culture Station, Big Spring Creek, North Newton Township, Cumberland County. Commonwealth of Pennsylvania Department of Environmental Protection, Internal Report, October 10, 2000. Stream file 2.21.0, Stream Code 10378. Harrisburg, Pennsylvania, USA.

Franz, Linda. "BSWA hopes to turn historic barrel factory into museum," September, 25, 2006, *The Sentinel (Carlisle PA).*

Ginsberg, M. and A. Palmer. 2002. Delineation of Source-water Protection Areas in Karst Aquifers of the Ridge and Valley and Appalachian Plateaus Physiographic Provinces: Rules of Thumb for Estimating the Capture Zones of Springs and Wells. EPA 816-R-02-015. www.epa.gov/safewater.

Häuselmann, P., Otz, M.H., and Jeannin, P.-Y., 2003, A review of the dye tracing experiments done in the Siebenhengste karst region (Bern, Switzerland): Eclogae Geologicae Helveticae, v. 96, p. 23-36

Hurd, T.M., Jesic, S., and S. Miller. 2004. Fish hatchery contribution to sediment organic matter and pollution tolerant isopods in Pennsylvania spring creeks. Ecological Society of America 2004 Annual Meeting, August 1 – 6, 2004, Portland, OR

Hurd, T.M., Brookhart, A., Otz, M.H., Otz, I., and Feeney. T.P. 2006. Variable transport of fluorescent tracers to springs of mantled karst in the Great Valley of Pennsylvania *in* Session H52A Chemical and Isotopic Tracing of Contaminated Groundwater. American Geophysical Union Joint Assembly. Baltimore, MD May 22-26, 2006.

Iwama. G.K. 1991. Interactions between aquaculture and the environment. Critical Reviews in Environmental Control 21(2):177-216.

Kacaroglu F (1999) Review of groundwater protection and pollution in karst areas. *Water Air and Soil Pollution* 113(1-4): 337-356.

Käss, W., 1998, Tracing technique in geohydrology: Rotterdam, A.A. Balkema, 581 p.

Kent, Barry C. 1989. Susquehanna's Indians.

Kochanov, W. E. 1989. *Sinkholes and Karst-Related Features of Cumberland County), Pennsylvania.* Open File Report series. PA Department of Environmental Resources.

Kressler, Robert A. 1965. The Saga of the Mills of the Big Spring in 175th Anniversary, Borough of Newville.

Land Partnerships. 2006. A countywide strategy for open space preservation and smart growth. Cumberland County open space preservation plan. Cumberland County Planning Commission. 18 North Hanover St., Suite 102, Carlisle, PA 17013.

Lorson, R., M. Marcinko, and T. Greene. 1987. Pennsylvania Fish and Boat Commission Big Spring Creek, Cumberland County Fishery Management Report.

Lindsey, B.D. Brookart, A., Hurd, T.M., Feeney, T.P. Otz M., and I. Otz. 2006. Conduit and Diffuse Flow in Great Valley Karst: The potential effect on springs and wells used for water supply. Session: Applied Hydrogeology and Environmental Geology for the 21st Century. The Geological Society of America Northeastern Section - 41st Annual Meeting, Camp Hill/Harrisburg, Pennsylvania 20–22 March 2006.

Miller, D. Jr., Jesic, S., Jerin, J., Britt, T., Amedume, Y., Fuller, N. and T.M. Hurd. 2007. Characterization of foodwebs in limestone springs using stable isotopes. Fourth Annual Meeting of the Ecological Society of America, Mid-Atlantic Chapter. York College, York, PA, March 17, 2007.

NATURAL AREAS INVENTORY OF CUMBERLAND, DAUPHIN AND PERRY COUNTIES, PENNSYLVANIA Update – 2005 Prepared by: The Pennsylvania Science Office of The Nature Conservancy Submitted to: The Tri-County Regional Planning Commission Dauphin County Veterans Memorial Office Building 112 Market Street, Seventh Floor Harrisburg, PA 17101-2015

Otz, M.H., Hinchey, E.J., Siegel, D.I., Otz, H.K., and Otz, I., 2004, Fluorescent dye-tracing as a cost-effective tool in applied contaminant hydrology: a case study of synchronous spectro-fluorometry in a heavily oil-contaminated aquifer, in Proceedings on Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Assessment, and Remediation Conference, National Ground Water Association, p. 198-209.

Pennak, R. W. 1989. Fresh-water invertebrates of the United States, protozoa to molluska 3rd ed. John Wiley and Sons, New York, New York, USA.

Putnam, D. Hey, R.D., Clapsaddle, C., and Brannaka, L. 2004. Big Spring Creek Restoration Plan. Prepared for the Pennsylvania Fish and Boat Commission, February 9, 2004.

Ralston, M.R. and I.S. Oweis. 1999. Geotechnical Engineering Considerations for stormwater management in karst terraines. Southeastern Pennsylvania Stormwater Management Symposium. Implementing Best Management Practices. Villanova University October 21-22, 1999.

Rennert, B. 1994. Water pollution by a land-based trout farm. Journal of Applied Ichthyology 10:373-378.

Rife, Georgia Peffer. 1965. Springfield in 175th Anniversary, Borough of Newville.

Shires, N. 1997. A Postscript. Pages 12-34 *In* Limestone Legends: papers and recollections of the Fly Fishers' Club of Harrisburg 1947-1997. Compiled by Norm Shires and Jim Gilford. Stackpole Books, Mechanicsburg, PA.

Snyder E. and Carline R. 2002. Substrate Dissolved Oxygen Study in Big Spring. Unpublished Report.

Swain, William T. The Laying Out of Newville in 1790 on Presbyterian Property 1997.

U.S.D.A. 1980. Soil Survey of Cumberland and Perry Counties, Pennsylvania. United States Department of Agriculture/Soil Conservation Service (Natural Resource Conservation Service)

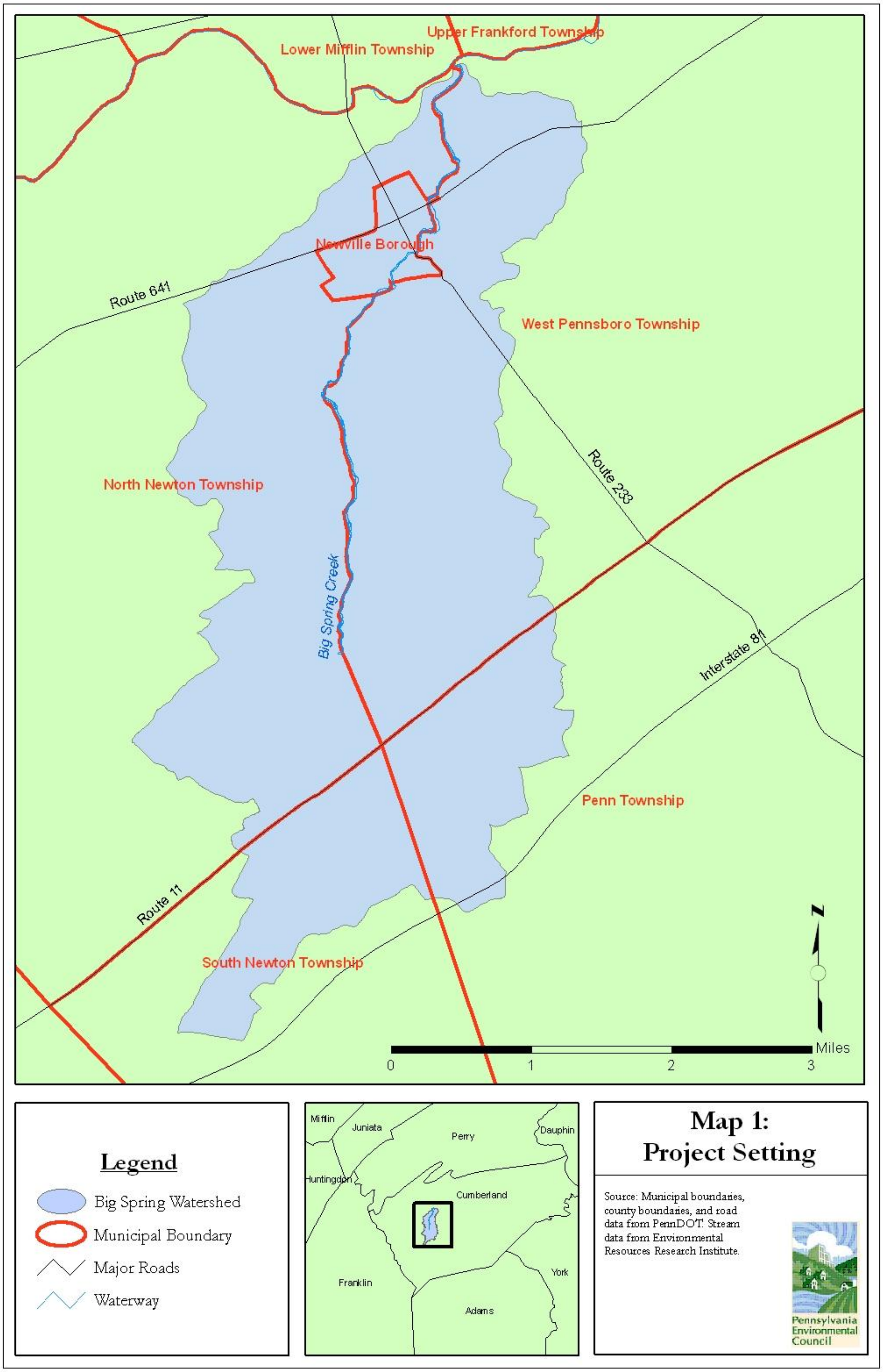
Veselic, M. 2003. Protection of groundwater in classical karst systems. Critical Reviews in Analytical Chemistry. 33(4):327-332.

Wallace, Paul A. Indians in Pennsylvania 1986.

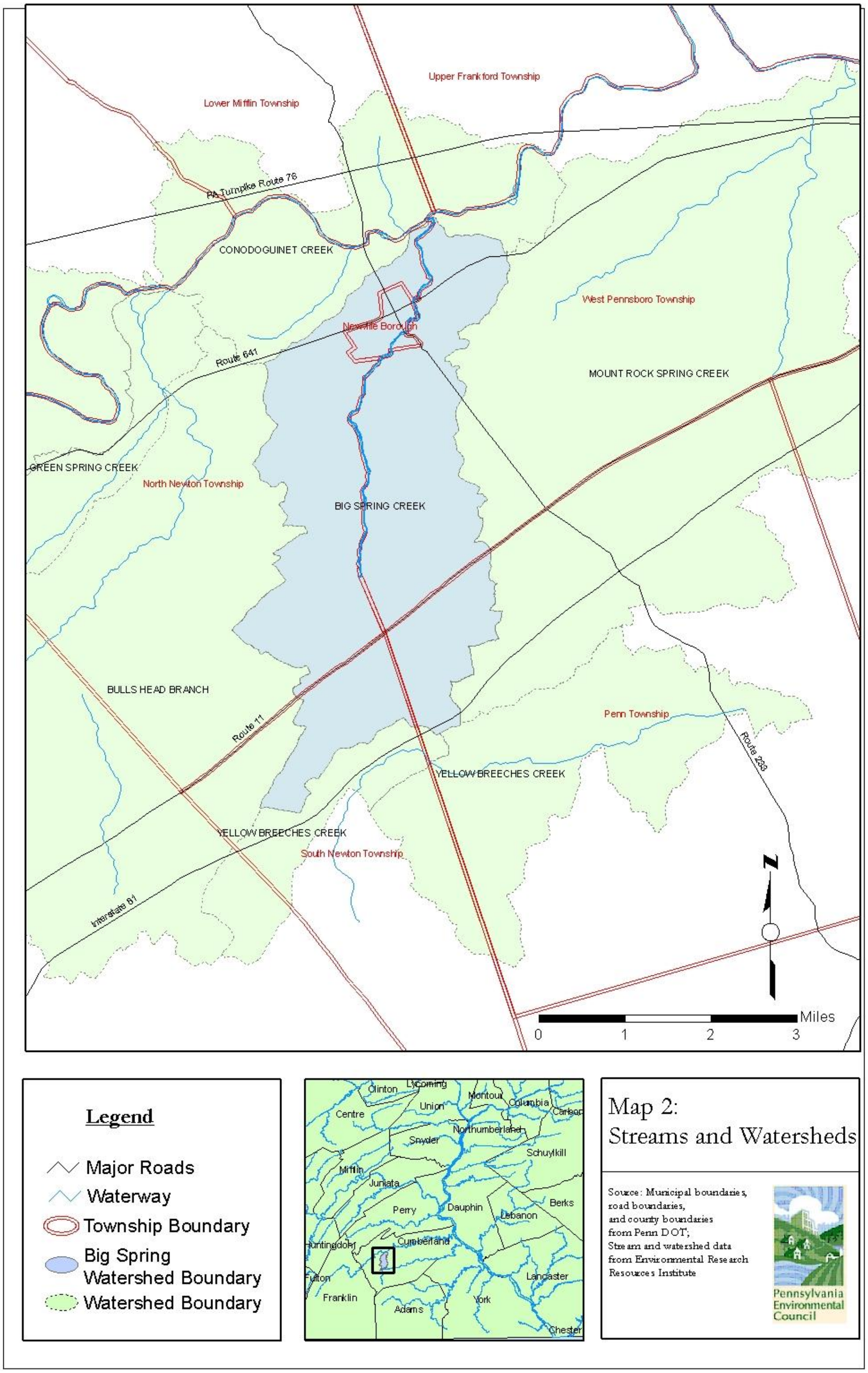
Warrer-Hansen. I. 1982. Evaluation of matter discharged from trout farming in Denmark. Pages 57-63 *in* J. S. Alabaster editor. Report of the EIFAC Workshop on Fish-Farm Effluents. Silkeborg, Denmark, 26-28 May 1981, European Inland Fisheries, Advisory Commission, Technical Paper No. 41, Food and Agriculture Organization of the United Nations, Rome.

Woods, Lloyd. Big Spring Presbyterian Church in 175th Anniversary, Borough of Newville.

Appendix 1 – Maps



Upper Frankford Township
Lower Mifflin Township
Newville Borough
Route 641
West Pennsboro Township
North Newton Township
Route 233
Big Spring Creek
Interstate 81
Penn Township
Route 11
South Newton Township
N
Miles
0
1
2
3
Legend
Big Spring Watershed
Municipal Boundary
Major Roads
Waterway
Mifflin
Juniata
Perry
Dauphin
Huntingdon
Cumberland
Franklin
York
Adams
Map 1:
Project Setting
Source: Municipal boundaries, county boundaries, and road data from PennDOT. Stream data from Environmental Resources Research Institute.
Pennsylvania Environmental Council



Upper Frankford Township
Lower Mifflin Township
PA Turnpike Route 76
CONODOGUINET CREEK
West Pennsboro Township
Newville Borough
Route 641
MOUNT ROCK SPRING CREEK
GREEN SPRING CREEK
North Newton Township
BIG SPRING CREEK
BULLS HEAD BRANCH
Route 11
Penn Township
Route 233
YELLOW BREECHES CREEK
YELLOW BREECHES CREEK
South Newton Township
Interstate 81
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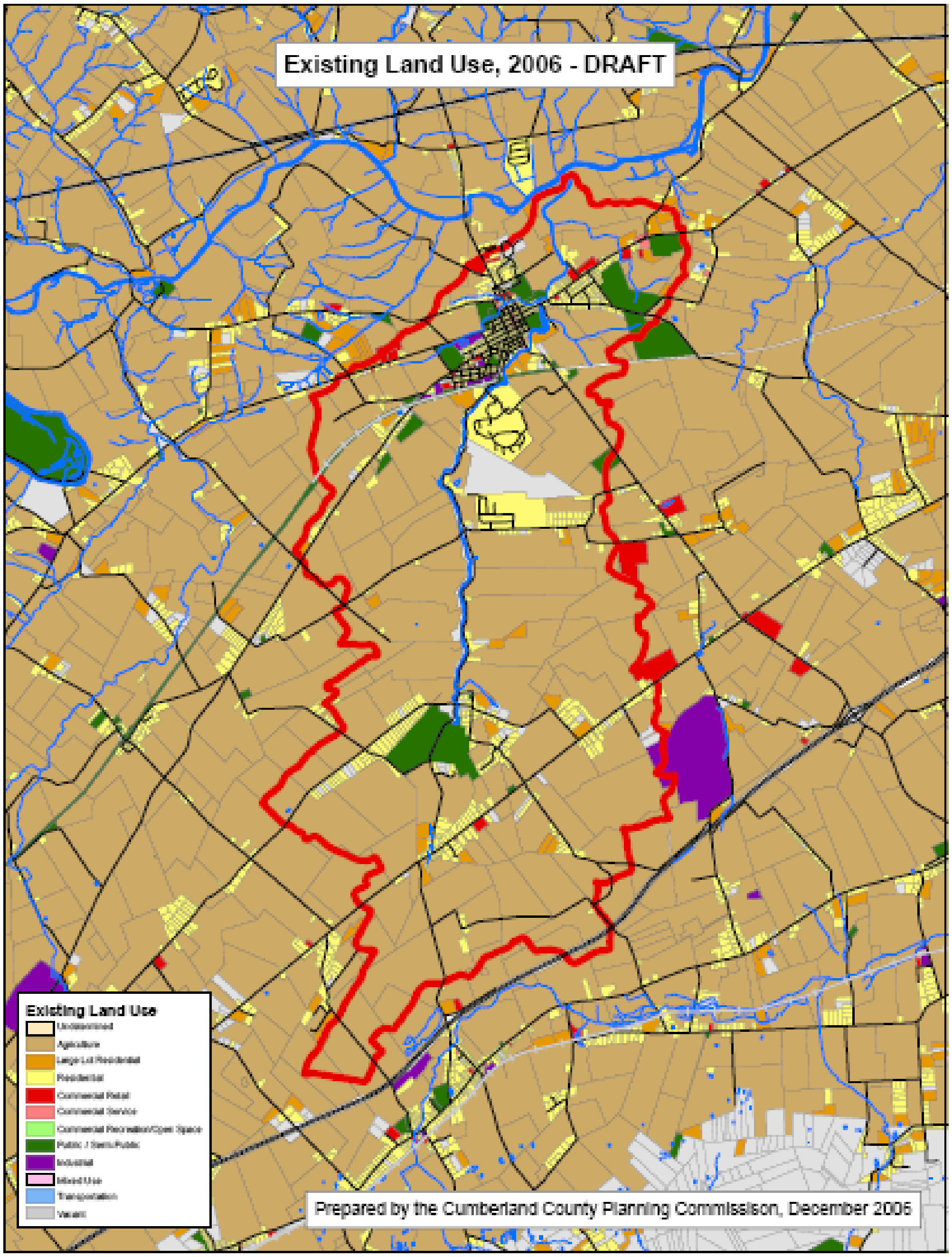
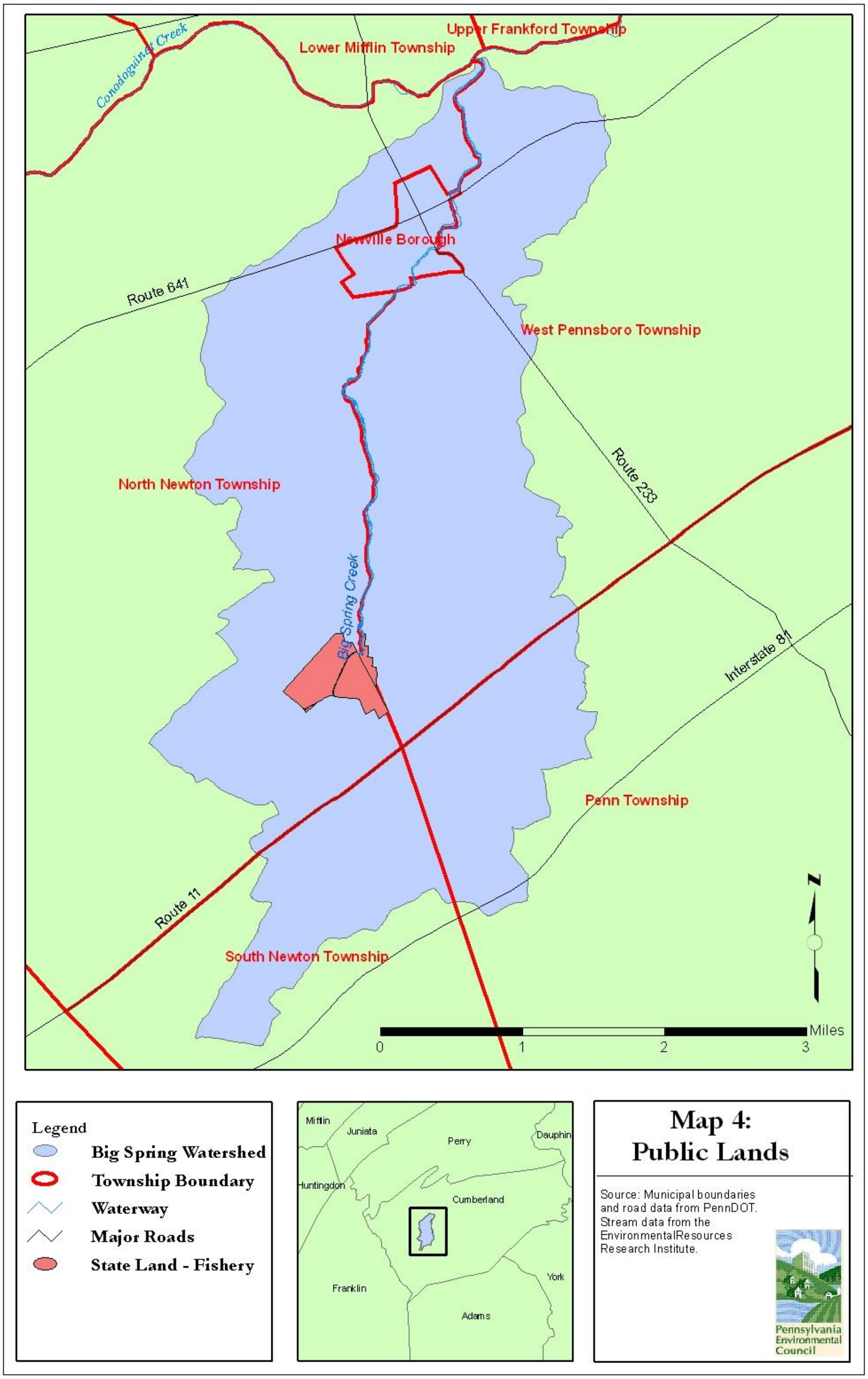
Major Roads
Waterway
Township Boundary
Big Spring Watershed Boundary
Watershed Boundary
Clinton
Lycoming
Centre
Union
Montour
Columbia
Carbo
Snyder
Northumberland
Schuylkill
Mifflin
Juniata
Perry
Dauphin
Lebanon
Berks
Huntingdon
Cumberland
ulton
Lancaster
Franklin
Adams
York
Chester
Map 2:
Streams and Watersheds
Source: Municipal boundaries, road boundaries, and county boundaries from Penn DOT; Stream and watershed data from Environmental Research Resources Institute
Pennsylvania Environmental Council

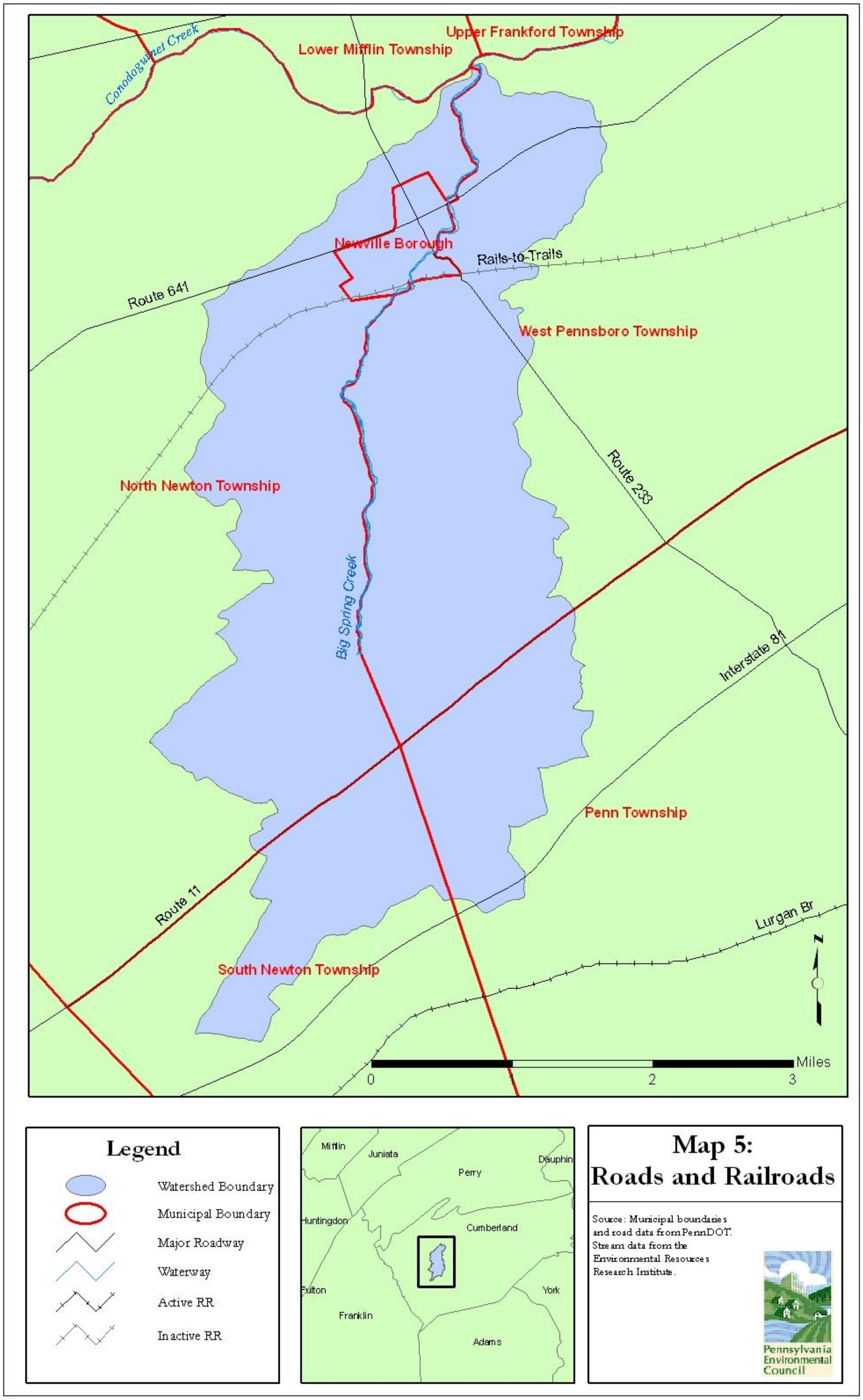


MAP 3 – Existing Land Use (DRAFT)



Map 4: Public Lands

Source: Municipal boundaries and road data from PennDOT. Stream data from the EnvironmentalResources Research Institute.


Upper Frankford Township
Lower Mifflin Township
Conodoguinet Creek
Newville Borough
Rails-to-Trails
Route 641
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North Newton Township
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Big Spring Creek
Interstate 81
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Watershed Boundary
Municipal Boundary
Major Roadway
Waterway
Active RR
Inactive RR
Mifflin
Juniata
Perry
Dauphin
Huntingdon
Cumberland
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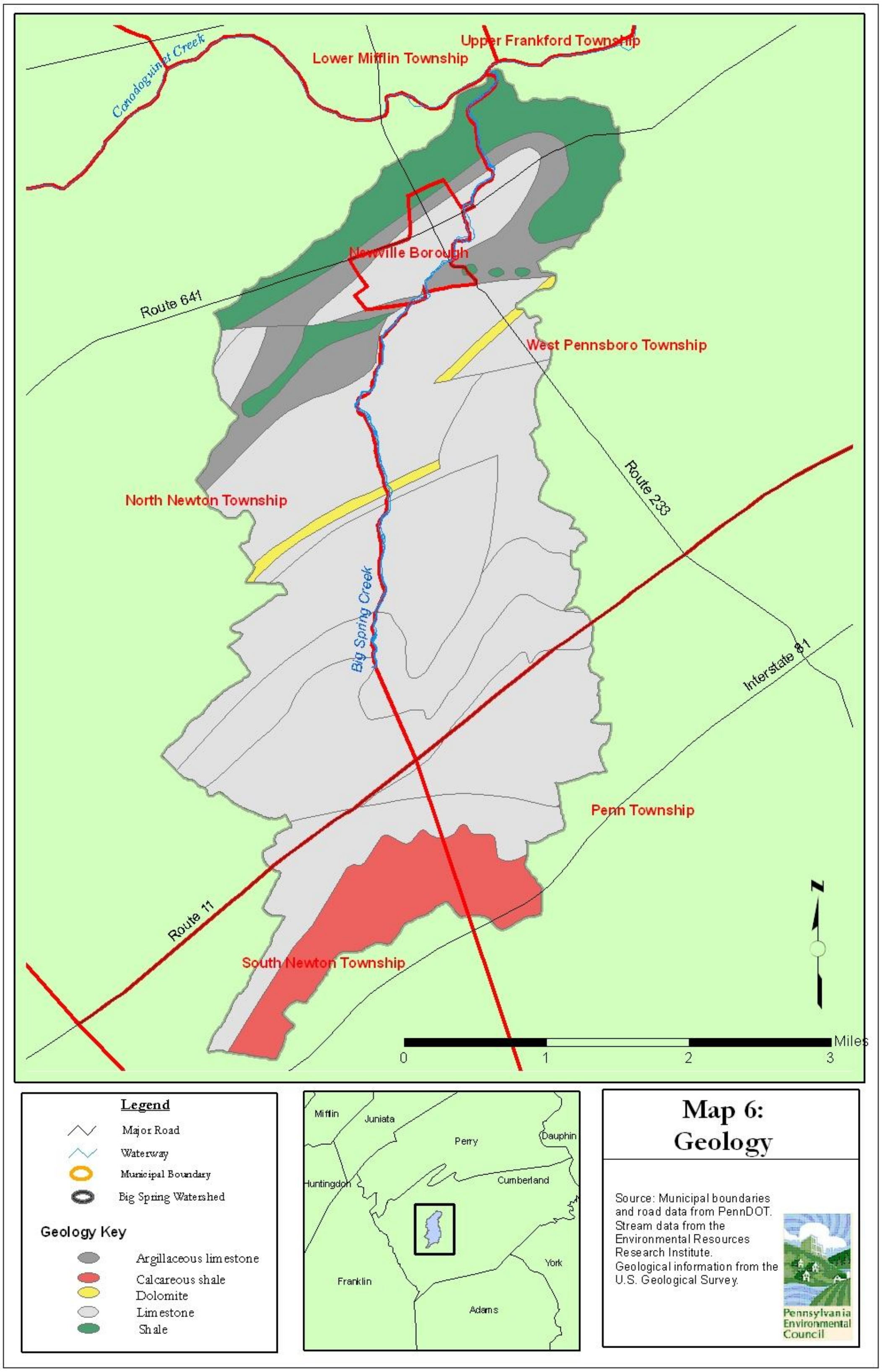
Map 5:
Roads and Railroads
Source: Municipal boundaries and road data from PennDOT. Stream data from the Environmental Resources Research Institute.
Pennsylvania Environmental Council


Upper Frankford Township
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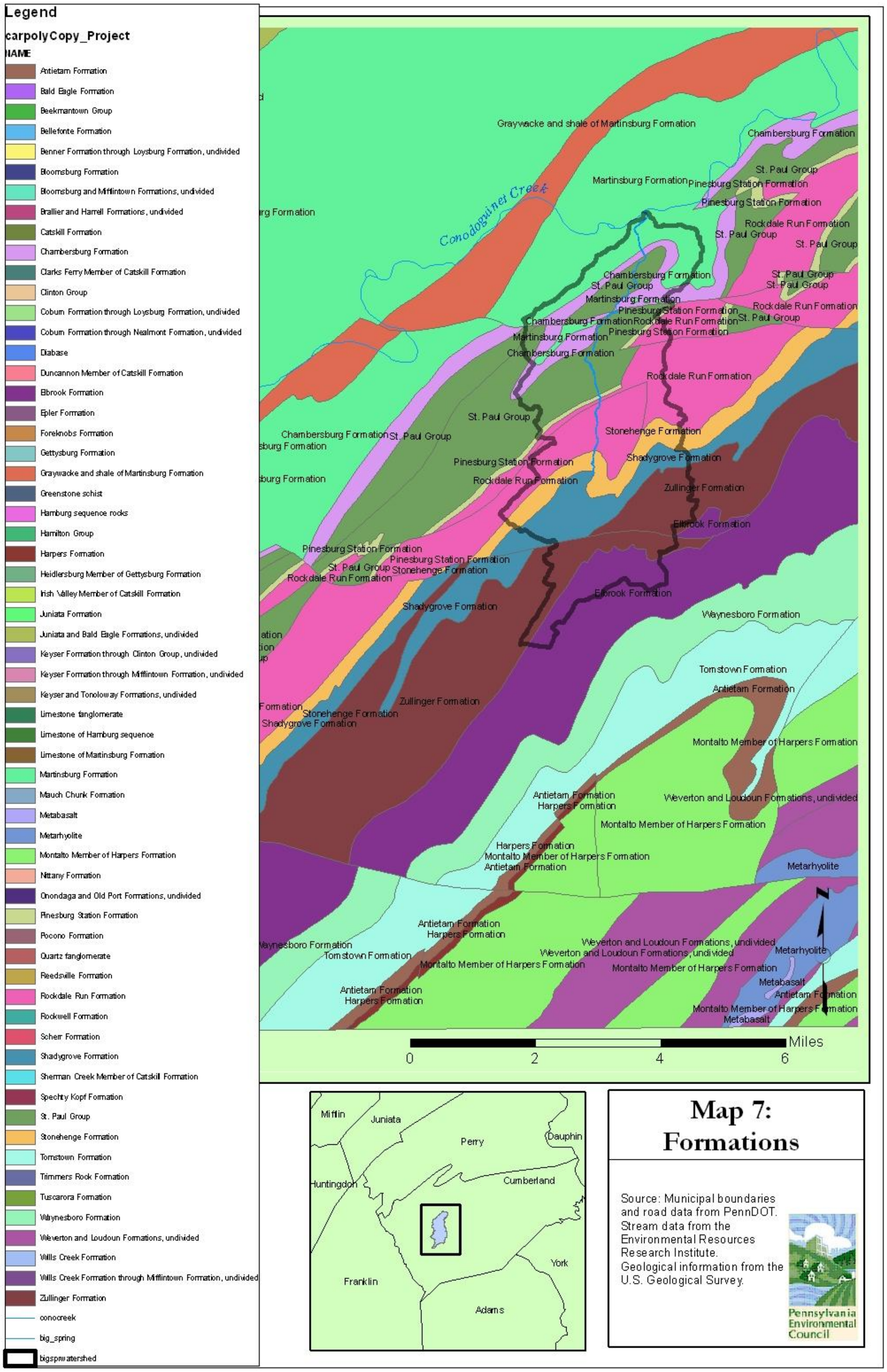
Major Road
Waterway
Municipal Boundary
Big Spring Watershed
Geology Key
Argillaceous limestone
Calcareous shale
Dolomite
Limestone
Shale
Mifflin
Juniata
Perry
Dauphin
Huntingdon
Cumberland
York
Franklin
Adams
Map 6:
Geology
Source: Municipal boundaries and road data from PennDOT. Stream data from the Environmental Resources Research Institute. Geological information from the U.S. Geological Survey.
Pennsylvania Environmental Council


Legend
carpolyCopy_Project
NAME
Antietam Formation
Bald Eagle Formation
Beekmantown Group
Bellefonte Formation
Benner Formation through Loysburg Formation, undivided
Bloomsburg Formation
Bloomsburg and Mifflintown Formations, undivided
Brallier and Harrell Formations, undivided
Catskill Formation
Chambersburg Formation
Clarks Ferry Member of Catskill Formation
Clinton Group
Coburn Formation through Loysburg Formation, undivided
Coburn Formation through Nealmont Formation, undivided
Diabase
Duncannon Member of Catskill Formation
Elbrook Formation
Epler Formation
Foreknobs Formation
Gettysburg Formation
Graywacke and shale of Martinsburg Formation
Greenstone schist
Hamburg sequence rocks
Hamilton Group
Harpers Formation
Heidlersburg Member of Gettysburg Formation
Irish Valley Member of Catskill Formation
Juniata Formation
Juniata and Bald Eagle Formations, undivided
Keyser Formation through Clinton Group, undivided
Keyser Formation through Mifflintown Formation, undivided
Keyser and Tonoloway Formations, undivided
Limestone fanglomerate
Limestone of Hamburg sequence
Limestone of Martinsburg Formation
Martinsburg Formation
Mauch Chunk Formation
Metabasalt
Metarhyolite
Montalto Member of Harpers Formation
Nittany Formation
Onondaga and Old Port Formations, undivided
Pinesburg Station Formation
Pocono Formation
Quartz fanglomerate
Reedsville Formation
Rockdale Run Formation
Rockwell Formation
Scherr Formation
Shadygrove Formation
Sherman Creek Member of Catskill Formation
Spechty Kopf Formation
St. Paul Group
Stonehenge Formation
Tomstown Formation
Trimmers Rock Formation
Tuscarora Formation
Waynesboro Formation
Weverton and Loudoun Formations, undivided
Wills Creek Formation
Wills Creek Formation through Mifflintown Formation, undivided
Zullinger Formation
conocreek
big_spring
bigsprwatershed
Graywacke and shale of Martinsburg Formation
Chambersburg Formation
Conodoguinet Creek
Martinsburg Formation
Pinesburg Station Formation
St. Paul Group
Rockdale Run Formation
Stonehenge Formation
Shadygrove Formation
Zullinger Formation
Elbrook Formation
Waynesboro Formation
Tomstown Formation
Antietam Formation
Montalto Member of Harpers Formation
Harpers Formation
Weverton and Loudoun Formations, undivided
Metarhyolite
Metabasalt
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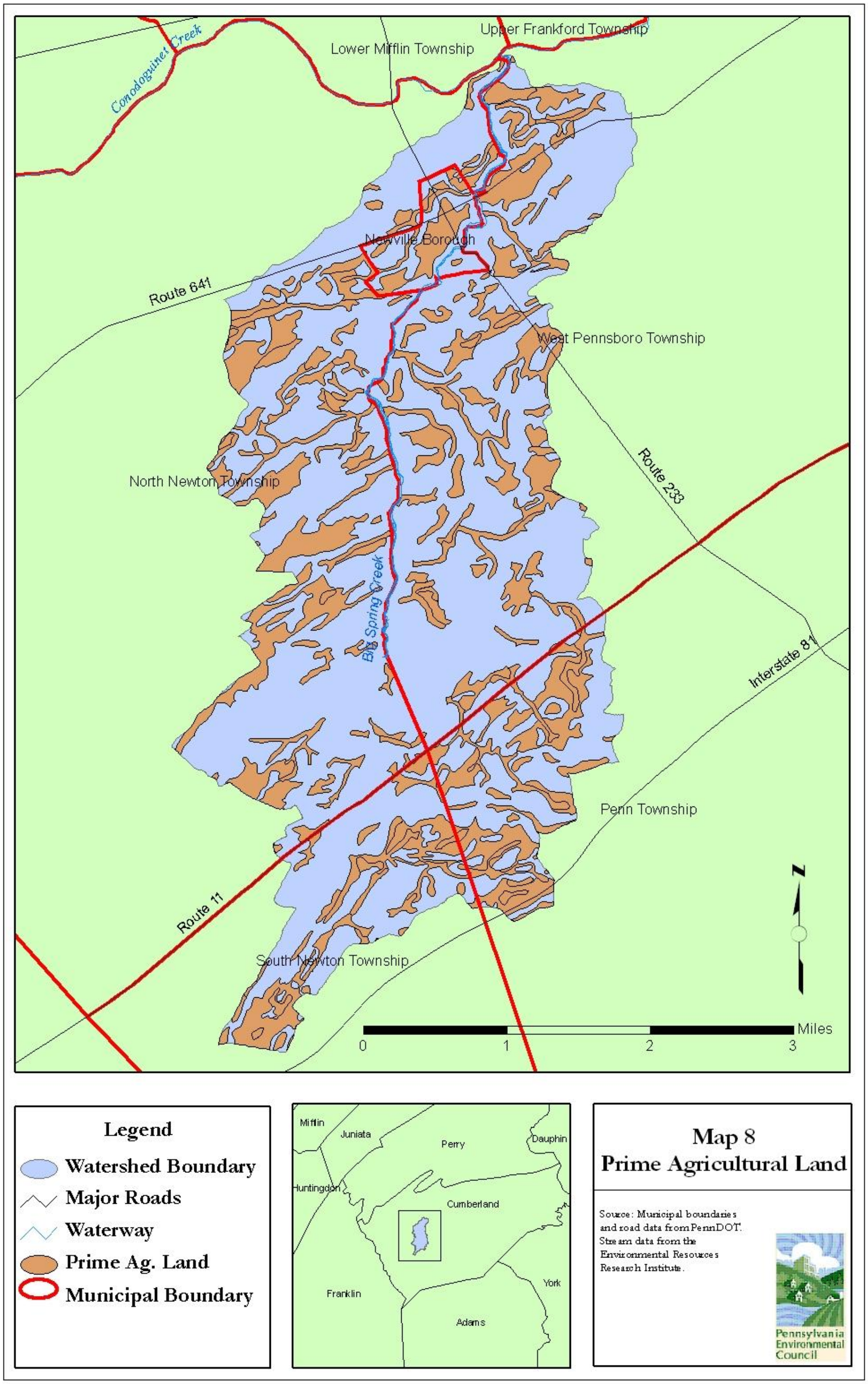
Miles
Mifflin
Juniata
Perry
Dauphin
Huntingdon
Cumberland
Franklin
York
Adams
Map 7:
Formations
Source: Municipal boundaries and road data from PennDOT. Stream data from the Environmental Resources Research Institute. Geological information from the U.S. Geological Survey.
Pennsylvania Environmental Council


Conodoguinet Creek
Lower Mifflin Township
Upper Frankford Township
Newville Borough
Route 641
West Pennsboro Township
North Newton Township
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Big Spring Creek
Interstate 81
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Watershed Boundary
Major Roads
Waterway
Prime Ag. Land
Municipal Boundary
Mifflin
Juniata
Perry
Dauphin
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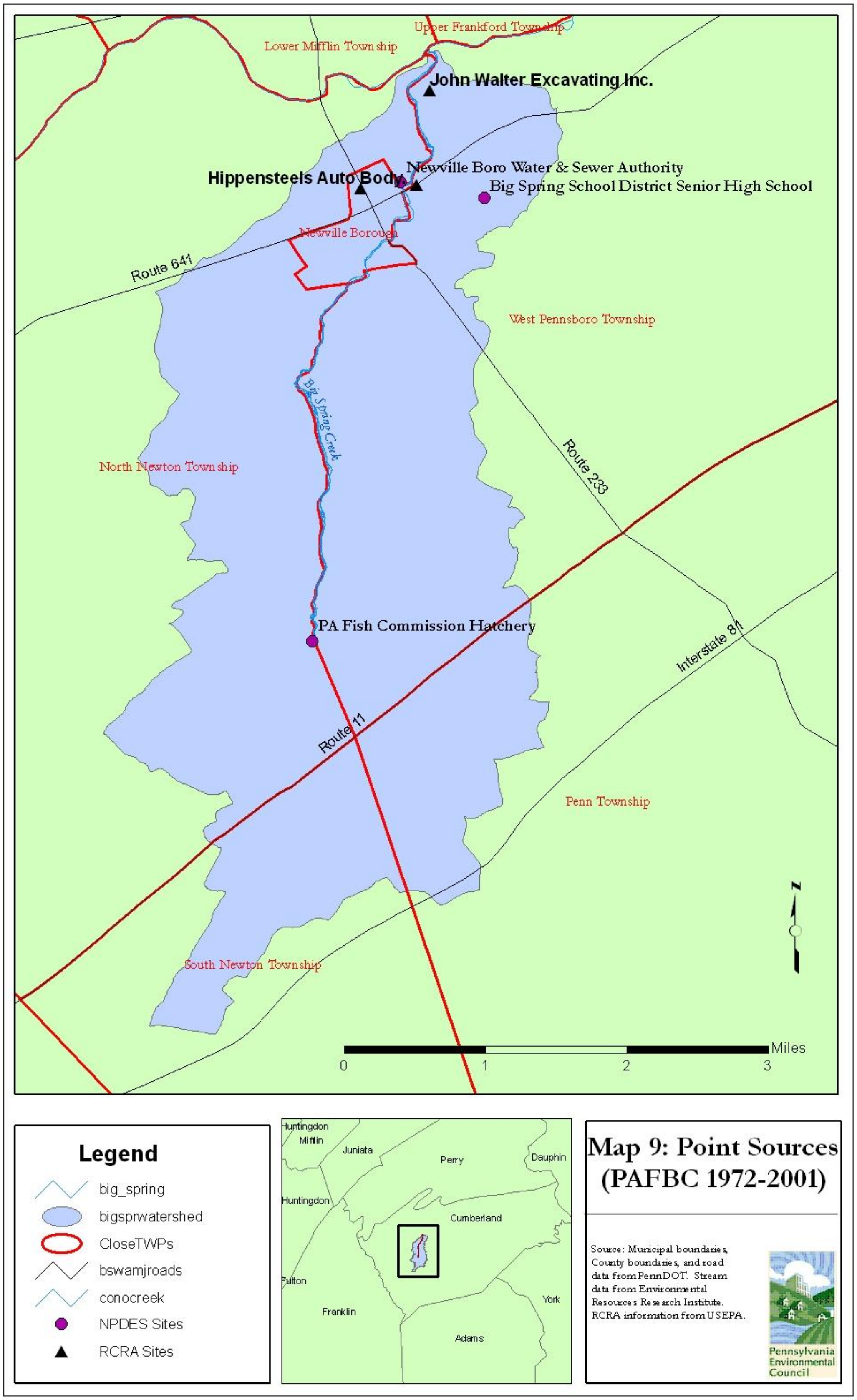
Map 8
Prime Agricultural Land
Source: Municipal boundaries and road data from PennDOT. Stream data from the Environmental Resources Research Institute.
Pennsylvania Environmental Council



Upper Frankford Township
Lower Mifflin Township
John Walter Excavating Inc.
Newville Boro Water & Sewer Authority
Hippensteels Auto Body
Big Spring School District Senior High School
Newville Borough
Route 641
West Pennsboro Township
Big Spring Creek
North Newton Township
Route 233
PA Fish Commission Hatchery
Interstate 81
Route 11
Penn Township
South Newton Township
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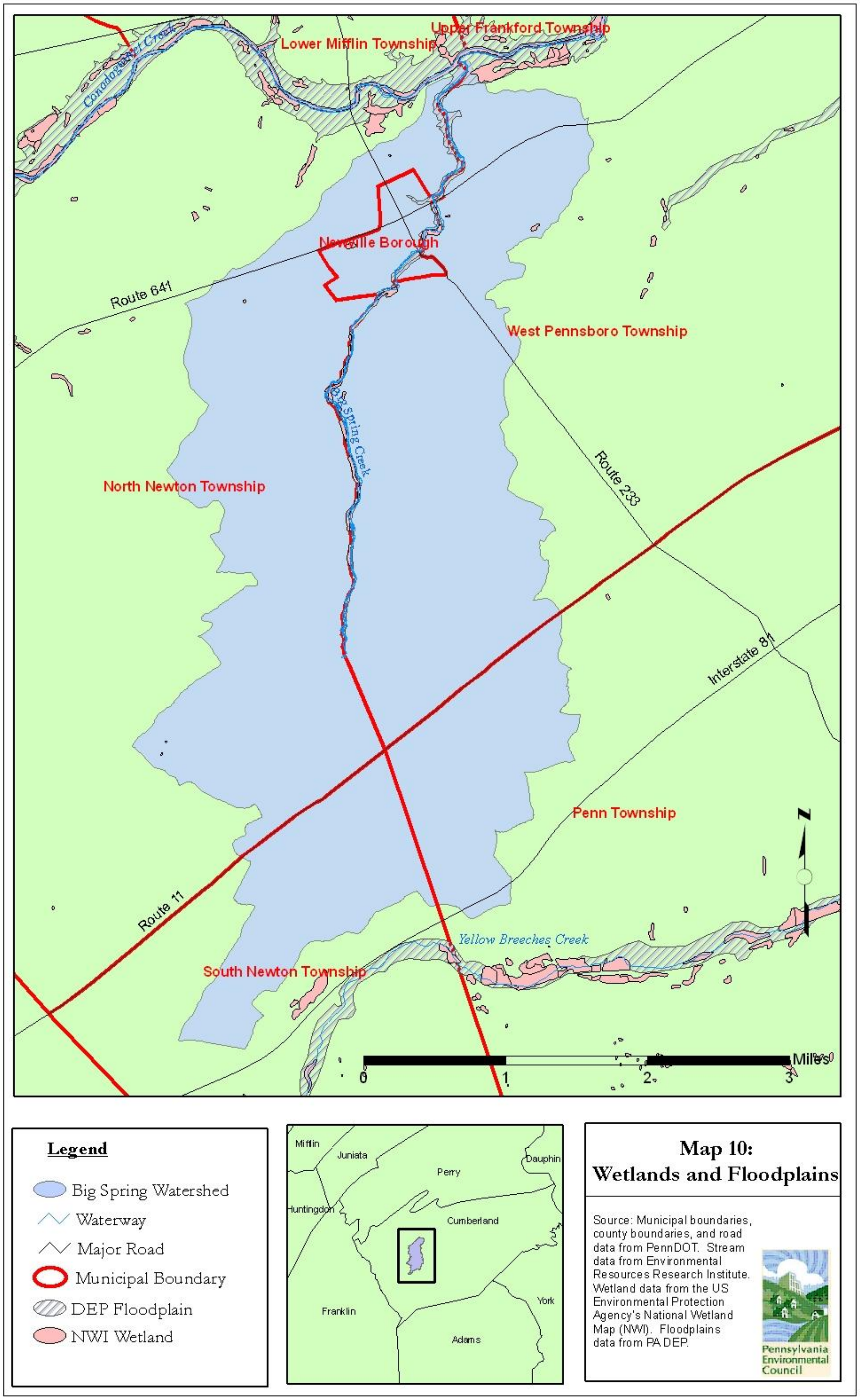
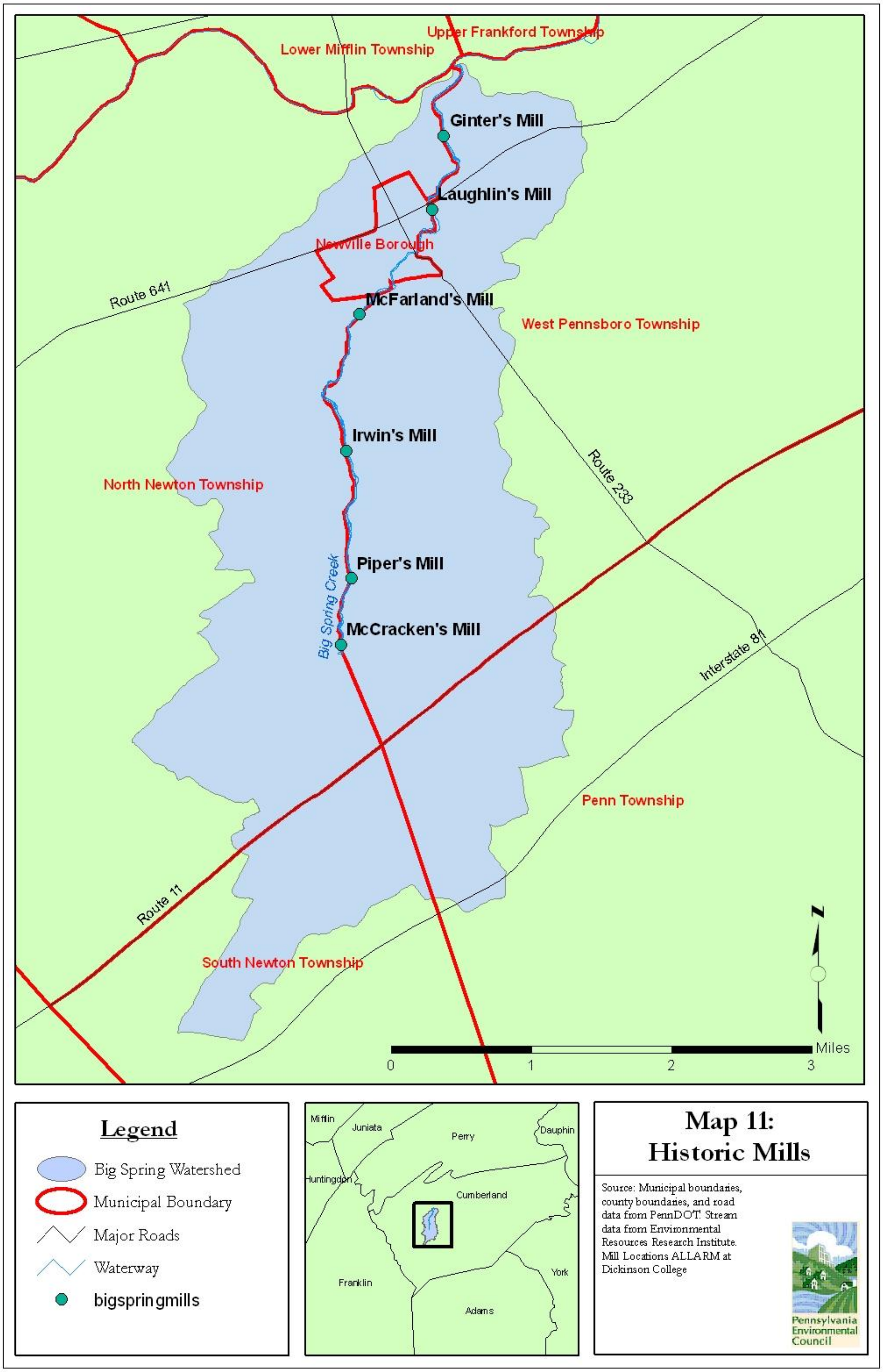
big_spring
bigsprwatershed
CloseTWPs
bswamjroads
conocreek
NPDES Sites
RCRA Sites
Huntingdon
Mifflin
Juniata
Perry
Dauphin
Huntingdon
Cumberland
Fulton
Franklin
York
Adams
Map 9: Point Sources
(PAFBC 1972-2001)
Source: Municipal boundaries, County boundaries, and road data from PennDOT. Stream data from Environmental Resources Research Institute. RCRA information from USEPA.
Pennsylvania Environmental Council



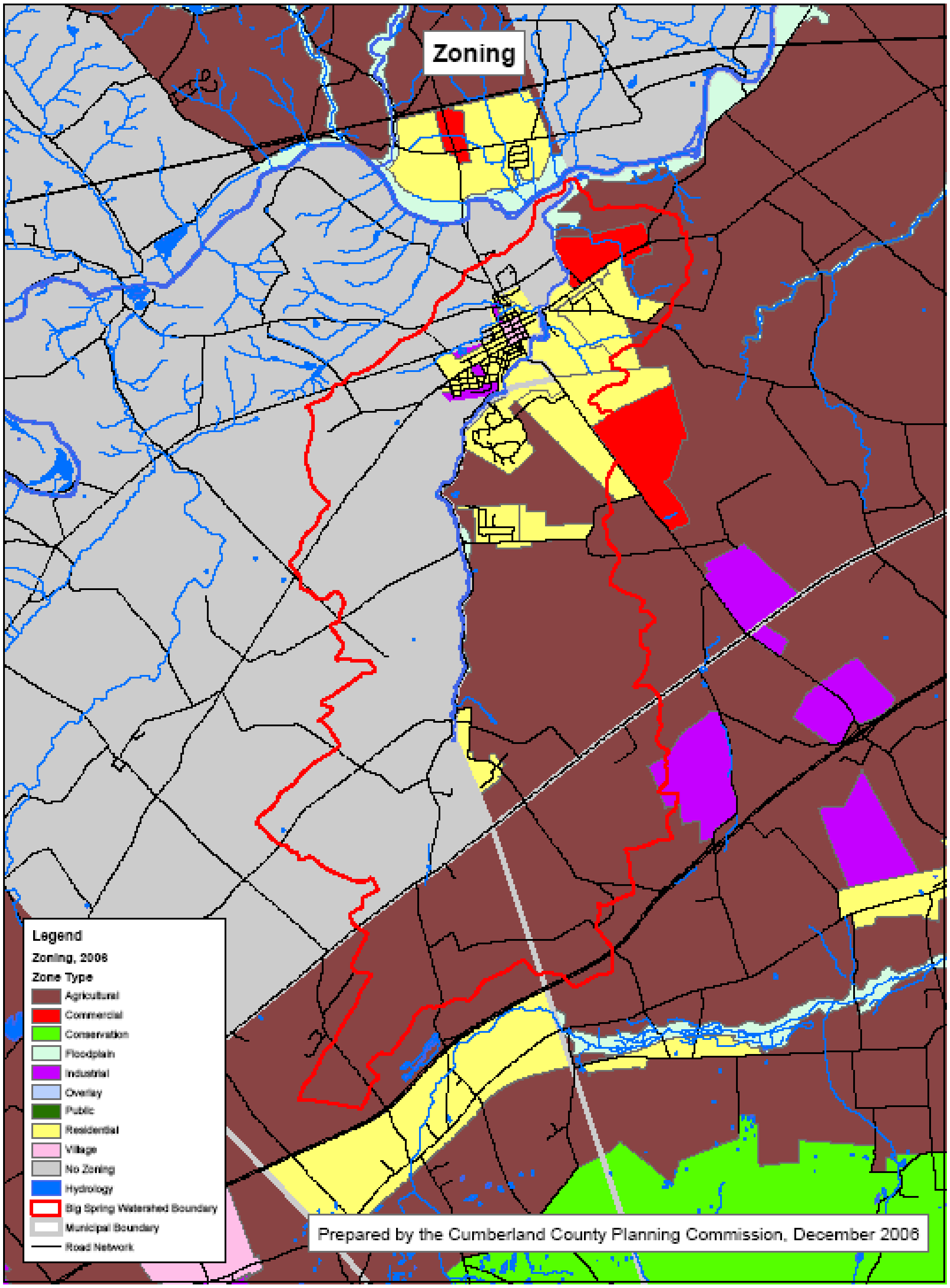
Map 10: Wetlands and Floodplains

Source: Municipal boundaries, county boundaries, and road data from PennDOT. Stream data from Environmental Resources Research Institute. Wetland data from the US Environmental Protection Agency's National Wetland Map (NWI). Floodplains data from PA DEP.



Map 11: Historic Mills

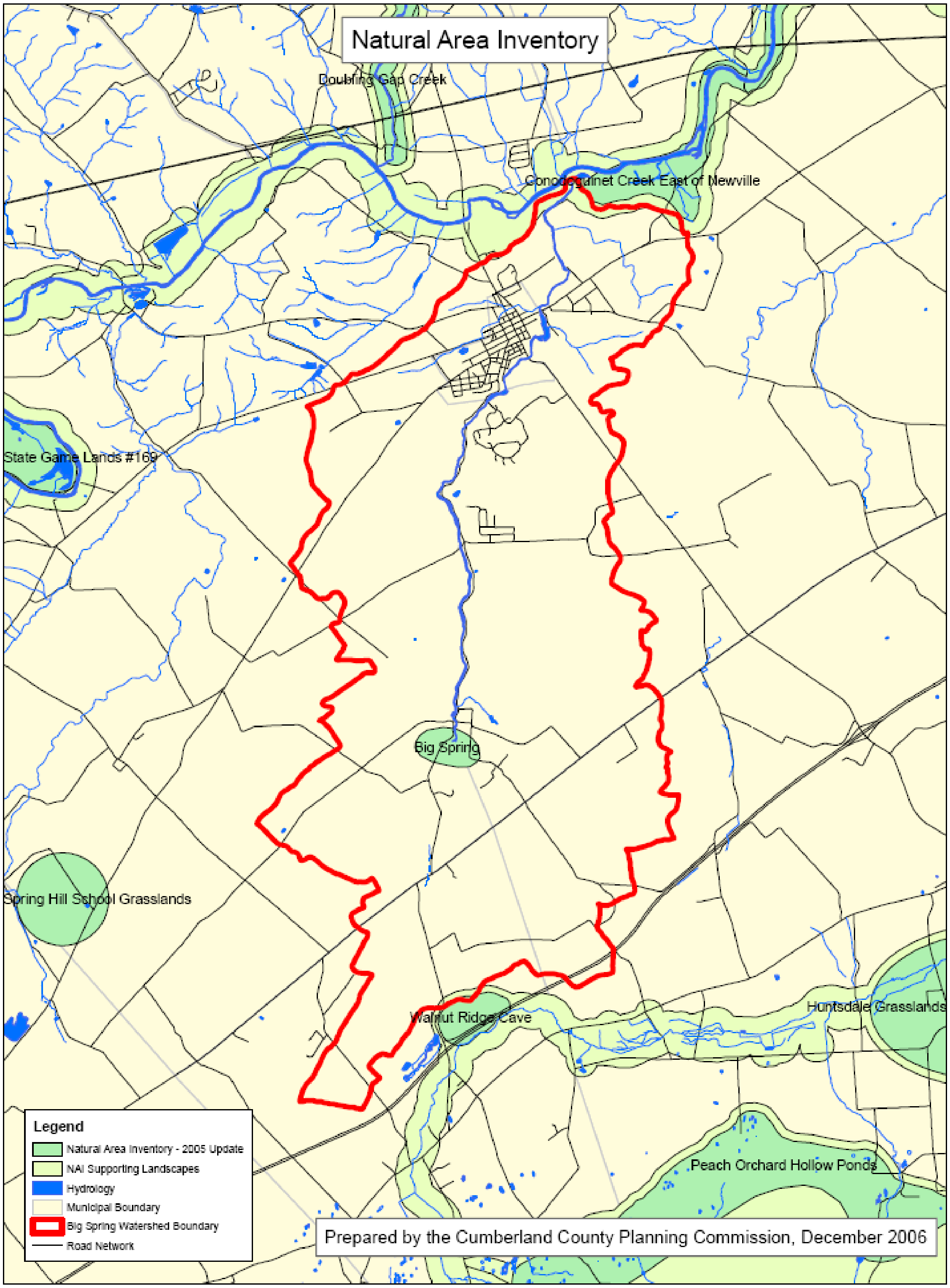
Source: Municipal boundaries, county boundaries, and road data from PennDOT. Stream data from Environmental Resources Research Institute. Mill Locations ALLARM at Dickinson College



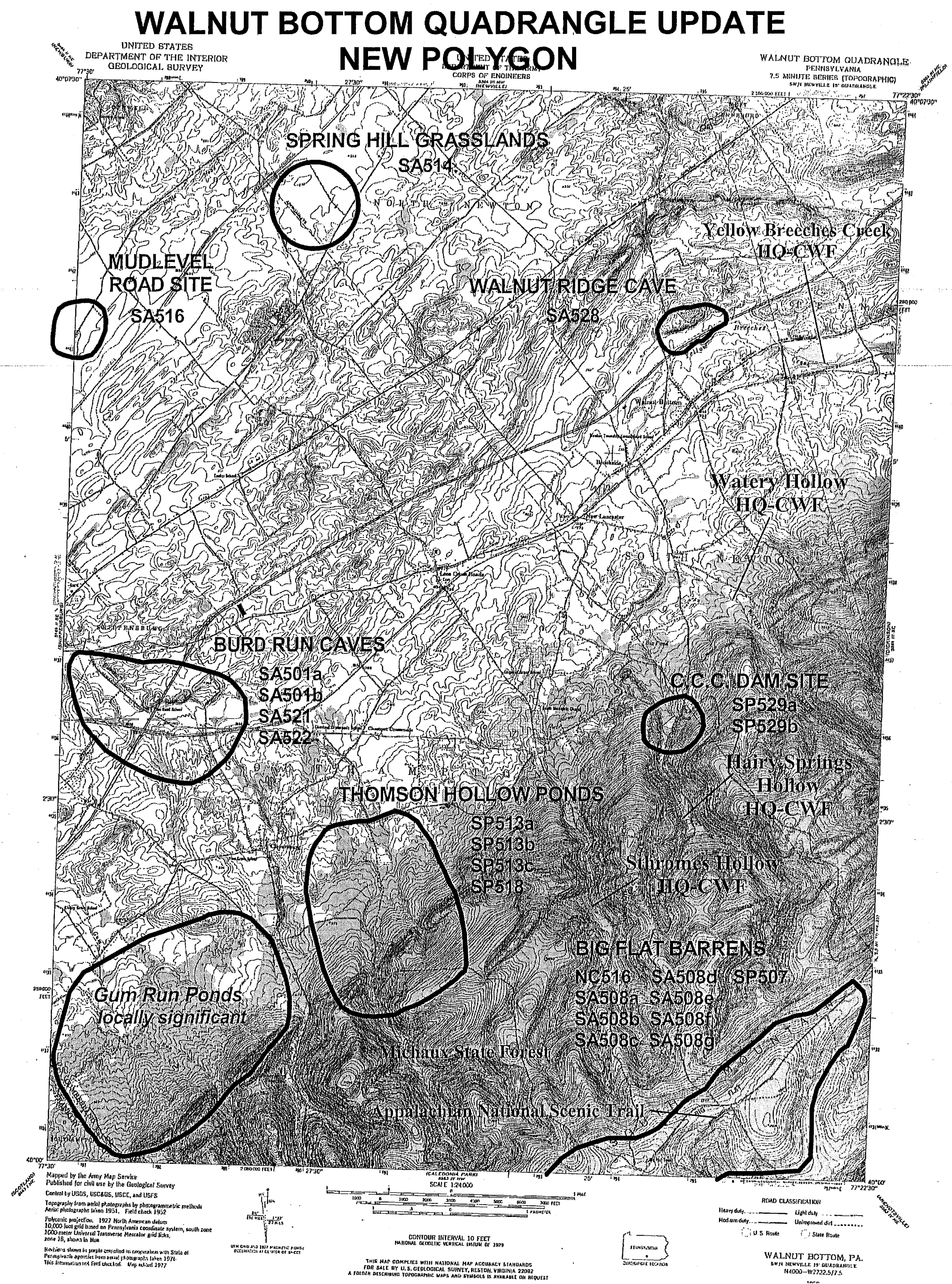
MAP 12 – Zoning

Appendix 2 – Tricounty Natural Area Survey sites near Big Spring surface watershed

a. 2005 update (Map provided by Cumberland County Planning Commission)



b. 2002 update showing other regional natural areas of significance within possible contributing areas of Big Spring



Appendix 3 – Trout populations surveyed by Pennsylvania Fish and Boat Commission during years of hatchery operation (Lorsen et al. 1987; PAFBC electrofishing summaries)

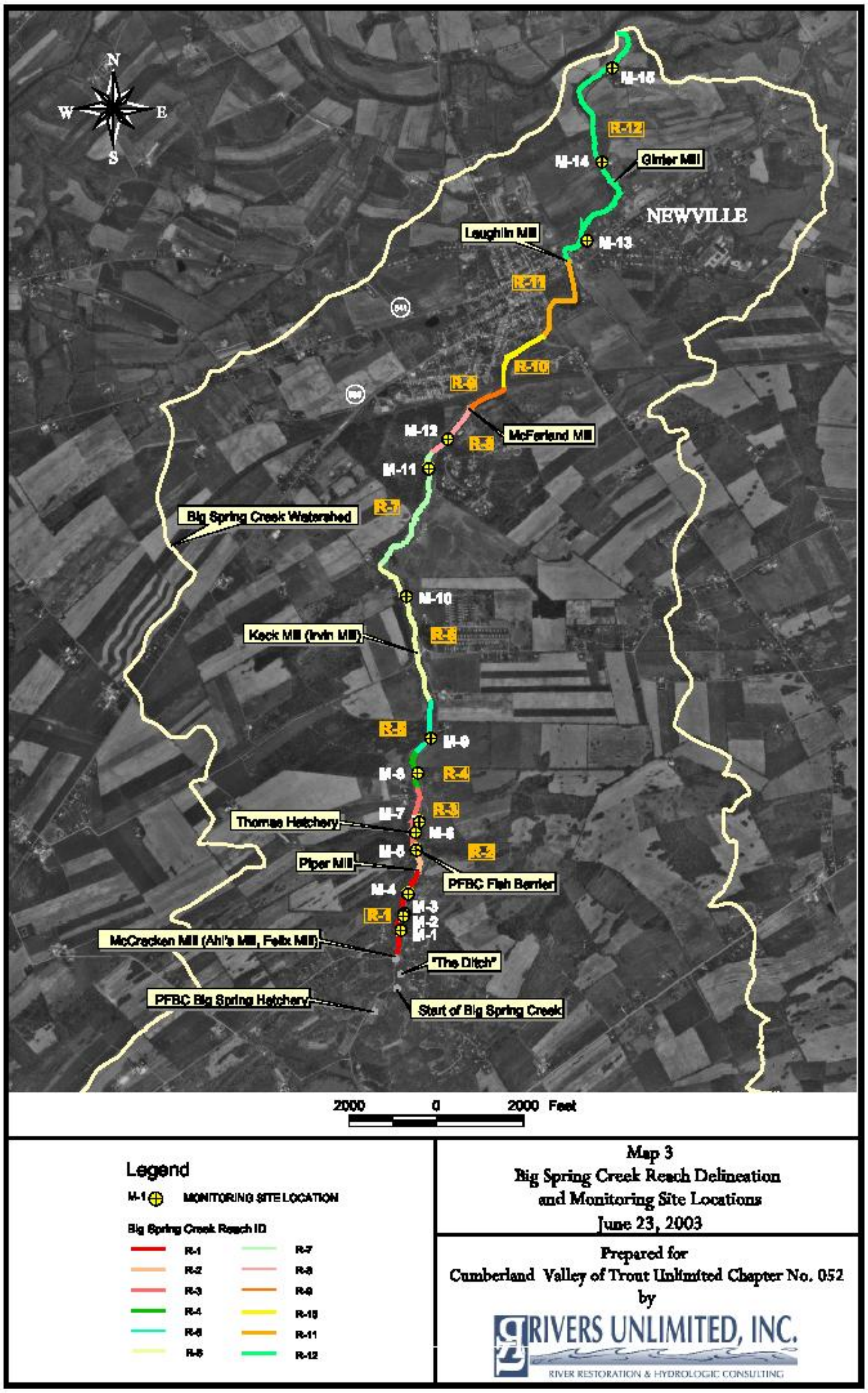
Table 4. Big Spring Creek (7B) Estimated Abundance (N/ha) and Biomass (kg/ha) for Rainbow Trout at Section 02 from 1977 to 1981 and 1983 through 1986 and 1988.

Length Gr. (mm)	1977 (N/ha)	1977 (kg/ha)	1978 (N/ha)	1978 (kg/ha)	1979 (N/ha)	1979 (kg/ha)	1980 (N/ha)	1980 (kg/ha)	1981 (N/ha)	1981 (kg/ha)	1983 (N/ha)	1983 (kg/ha)	1984 (N/ha)	1984 (kg/ha)	1985 (N/ha)	1985 (kg/ha)	1986 (N/ha)	1986 (kg/ha)	1988 (N/ha)	1988 (kg/ha)
125													1	0.04						
150					1	0.10	1	0.05	1	0.05					1	0.03	1	0.01	1	0.01
175			1	0.02	1	0.09	1	0.09			1	0.09			1	0.09				
200			1	0.05	1	0.15	3	0.32			1	0.10			1	0.09	1	0.03	1	0.03
225	1	0.16	1	0.03	1	0.16	1	0.17	1	0.20	1	0.12	1	0.14			1	0.05		
250					2	0.43	2	0.44			1	0.16					1	0.05		
275			1	0.05	1	0.24	1	0.32	1	0.24	2	0.48					1	0.15	1	0.07
300	1	0.34	1	0.40	3	1.09	1	0.41	2	0.79	1	0.38	1	0.33	1	0.33	2	0.57		
325	2	0.75	4	1.84	2	1.12	1	0.48	1	0.47	1	0.46	2	0.94	1	0.35	3	1.32	1	0.23
350	1	0.54	6	4.29	4	2.64	2	1.29	1	0.65	2	1.07	1	0.72	1	0.38	1	0.85	1	0.15
375	2	1.50	6	4.44	1	0.70	3	2.06	1	0.75	2	1.51	1	0.88	1	0.70	1	0.25	1	0.34
400	1	0.78	2	1.61	2	1.90	1	0.88	1	0.88	1	0.85			1	0.78	1	0.49		
425	1	1.06	1	0.42	1	1.30	1	0.94	1	0.94	1	0.90	1	1.35	1	0.85			1	0.25
450			1	0.36			1	1.38	1	1.05			1	1.10			1	0.90		
475			1	0.40	1	1.48	1	1.64	1	1.35	1	1.78								
500							1	1.84												
525																				
550															1	1.90				
575																				
	9	5.13	26	13.91	21	11.40	21	12.13	12	7.37	15	7.91	9	5.30	10	5.50	14	4.67	7	1.08

Big Spring Creek (7B) Estimated Abundance (N/ha) and Biomass (kg/ha) of Brook Trout from the Barrier to the Ditch from 1986 to 1992.

Length Gr. (mm)	1986 (N/ha)	1986 (kg/ha)	1987 (N/ha)	1987 (kg/ha)	1988 (N/ha)	1988 (kg/ha)	1989 (N/ha)	1989 (kg/ha)	1990 (N/ha)	1990 (kg/ha)	1991 (N/ha)	1991 (kg/ha)	1992 (N/ha)	1992 (kg/ha)
50	1	0.01			1	0.01								
75	19	0.13	5	0.04	7	0.05	6	0.03	25	0.20	7	0.06	8	0.05
100	37	0.48	22	0.28	86	1.20	5	0.06	43	0.61	49	0.63	14	0.14
125	22	0.48	31	0.70	19	0.39	2	0.07	15	0.40	21	0.47	13	0.29
150	2	0.09	7	0.28	7	0.32	1	0.02	1	0.05	1	0.06	4	0.17
175	1	0.04	1	0.04	1	0.06			1	0.07	1	0.04	1	0.03
200			2	0.19	1	0.05	5	0.66	1	0.06	4	0.48	4	0.39
225	1	0.07	2	0.33	3	0.48	9	1.49	3	0.50	16	2.39	5	0.71
250	1	0.10	3	0.59	5	1.13	22	4.86	5	1.17	13	2.45	7	1.29
275	4	1.17	6	1.49	9	2.39	10	2.81	1	0.25	1	0.39	1	0.22
300	2	0.67	1	0.39	3	1.39	3	1.23	3	1.02	1	0.31	1	0.16
325	1	0.21	3	1.30	1	0.68			1	0.78	1	0.44	1	0.57
350	1	0.30	1	0.89	1	0.89	3	1.72	1	0.52			1	0.30
375	1	0.33	1	0.38	1	0.42			1	0.33				
400			1	0.47					1	0.39				
425					1	0.58								
	93	4.08	86	7.37	146	10.04	66	12.95	102	6.35	115	7.72	60	4.32

Appendix 4 – Study reaches of Clapsaddle's (2003) hydrogeomorphic assessment of Big Spring



Appendix 5 – Public Survey Response Summaries

Question #1 How far do you travel to visit Big Spring?					
Less than 5	5-10	10-15	More than 15	Other (30-300 miles in distance)	No answer
79	1	3	4	6	2
83%	1%	3%	4%	6%	2%
95	total surveys returned				
Other Comments:					
	Less than 50 yards				
	30 miles				
	95 miles				
	120 miles				
	120 miles				
	150 miles				
	600 miles round trip				

Question #2 How do you and members of your household use, or would like to use Big Spring?																
Scenic drives	**Run/walk/ hike**	**Enjoy views**	Biking	Bird Watch	Horsebck	Fly fish	Spend time w frnds/fam	Enviro. Educ.	Picnic	Special events	Photo	Hunt/Trap	X-C Ski	Spin cast fish	Other	No answer
62	**53**	**77**	25	43	2	34	30	19	16	7	34	7	5	24	7	2
65%	**56%**	**81%**	26%	45%	2%	36%	32%	20%	17%	7%	36%	7%	5%	25%	7%	2%
95	total surveys returned															
Other Comments:																
	Live bait fishing															
	Live along the Spring/Sit on porch watching flow (2)															
	Boating use (2)															
	Tubing															
	Take dog swimming															

Question #3 What prevents your or members of your household from using Big Spring or lands along the stream for recreation?										
Not enough access	Too far from where I live	**Don't know what's available to do**	Stream bank too steep	**No facilities**	Not interested	**Not enough time**	Dirty water	Dislike the stream	Other	No answer
17	7	**11**	3	**14**		**16**	8	3	24	29
18%	7%	**12%**	3%	**15%**	0%	**17%**	8%	3%	25%	31%
95	total surveys returned									
Other Comments:										
	Physical condition/small children (6)									
	Lack of parking, cars traveling too fast on road (2)									
	Nothing really prevents use (4)									
	Weeds and silt make fishing more difficult (3)									
	Lack of more facilities (motels, picnic tables, porta-potties) (4)									
	Difficult/dangerous to walk. bike along Big Spring Road (2)									
	Too low, took out the dams (silt, mud, rocks) (7)									

Question #4 Three qualities or characteristics of Big Spring area that are most important to you?									
Good Place to Live	**Home to species**	**Natural & scenic resrcs**	Brings tourism	Cultural/ Historic	Other	No response			
55	**72**	**78**	24	49	12	2			
58%	**76%**	**82%**	25%	52%	13%	2%			
95	total surveys returned								
Other Comments:									
	Fishing (blue water fishery potential, best wild rainbow and brook trout in state, fly fishing) (5)								
	Home to responder for many years (2)								
	Historic background (just a run now that dams were removed, miss old mills) (3)								
	Peaceful, undeveloped environment, except for Pennsy Quarry (2)								

Question #5 What Concerns do you have of the Big Spring Creek area?								
Water Quality	Flooding	**Develop. Pressures**	Erosion	**Water Quantity**	Endangered Species	Drainage	Other	No response
81	2	**58**	37	**44**	22	15	13	5
85%	2%	**61%**	39%	**46%**	23%	16%	14%	5%
95	total surveys returned							
Other Comments:								
Green Ridge Village sewer overflow (2)								
type of trout being stocked								
farm chemicals								
dead trees & branches (2)								
silt build up								
unattractive area on Green Ridge Village entrance								
put a dam back in like it used to be, natural spring								
water will be a precious future resource								
contamination from quarry								
invasive plant species								
habitat diversity								

Question #6 What do you like most about the Big Spring? What special places in the Big Spring watershed would you consider important and worth recognizing in the plan?

Scenic/Historic Character (Total responses: 15)

It's beauty and the attraction for birds and animals. The creek from which it comes out of rock (2) along Big Spring Road to and including Newville's old mill.

Beauty, history, quality of fishery. I am only familiar with the upper reaches.

It's a beautiful, restful, inspiring area.

It's gorgeous along the spring, windy road, heron, ducks, geese and historical path to Shippensburg, old houses, farmland. I always to that way to Shippensburg. My daily walk is from Newville, along Spring road, up around Green Ridge Village. You never know what you are going to see.

The natural scenic value. Should be public access to the outlet.

Its naturalness

The beauty

The two lane winding road from Newville to Springfield Road is beautiful. The bridge is finally completed and is picture perfect. Our daughter had her wedding party perched on top for wonderful photos.

Quiet, natural environment

Cool water, wildlife, peacefulness. I have memories of afternoons swimming and walking in the waters of the Newville dam.

The natural beauty

Very serene, no one particular spot.

The feeling of amazement at how left alone the area has been. The farms and old houses that border the creek.

I appreciate the uncluttered views of the spring i.e. only a few simple signs, not cluttered with trash containers, bleachers, seats, tables in all the pull off areas.

The beauty of it, the barrel factory, ability to canoe or tube on it.

Valuable Resource (Total responses: 13)

Its resiliency. Seen at its best and at its worst, hope and believe it will return with our consideration. but certainly the

The whole watershed is a valuable resource but certainly the upper reaches

I think that the entire stream is important and is quite fragile.

People enjoying fishing, bird watching, photography and a good supply of water.

I enjoy everything from the head of the spring to the mill.

The tremendous possibilities that exist in recreational, historical, cultural and environmental aspects of the area. Why the PA Fish Commission tore down a mill at the head of the Big Spring Creek with great historical value is asinine.

A good place to get away and calm down.

I don't know - I really enjoy the entire creek near my home (Big Spring Ave-Big Spring Rd.)

Fishing at the ditch. Walking from the ditch to the one lane bridge. The abundance of wildlife, good parking availability, the history of the creek.

We enjoy the clear water and history of the stream.

I like the facto that I can walk my family down to the water's edge and show my children the different life forms therein, just like my dad did for me.

I grew up in a home on the Spring and could see it from my home now if it weren't for the hill. Everything about it is important.

Clear, clean water that supports natural reproduction of brook trout plus the surrounding pastoral scenery is a photographer's dream.

I think the Big Spring Creek is a beautiful asset to this community. I think the whole creek is special and it is hard to specifically think of a few things or areas over another.

Water Resource (Total responses: 3)

Clear, free flowing water

I love hearing it go gently by in the night as I go to sleep.
The plan should look at the source water to make sure it stays from from NPS pollution
It is pretty, relaxing and winds through the area.

Fishing/Wildlife (Total responses: 14)
I am a fly fisherman who has fished Big Spring for 25 years so I am interested in brook trout restoration and fishing opportunities.

Good access for fishing.

Could be one of the best spring creeks in the area for trout fishing.

The potential for excellent trout fishing. The history of this stream is extraordinary.

I like the birds and wildlife in general. A naturally reproducing trout population should be established/preserved.

Trout fishing for wild trout. Preserve the rich history of the old grist mills that once flourished along the stream by adding interpretive signage where appropriate.

I like the wildlife possibilities at the spring i.e. geese, ducks, deer, etc.

Close, convenient and good trout stream. Dog like to swim there. See great blue heron.

I grew up with the spring and fished on it my entire life. The entire length of the spring needs to be worked on.

Used to be a great place to fish before spring started to get a lot of sediment in it.

The fishing and the scenery.

It provides a wonderful habitat for a wide diversity of bird species. In planning, I would hope that habitat requirements for birds would be given careful consideration.

Fly fishing the creek. Key are the parking pull offs for fishing.

Great fishing habitat.

Excellent wild trout fishing in the first mile or so. Regulations need to be adjusted to help wild fish survive in the open water areas.

Important Places Total responses: 14)
Save barrel factory.

The blue hole. The spot where the stream first surfaces. A scenic wonder. Before the PA Fish Commission took it over and built their structures.

Provides an awesome place to fish and relax. The mill in town is an important area historically and
environmentally.

I like the area near Big Spring and Log Cabin.

The old mills were once very interesting.

Historical water mill

The old mill and dam in Newville, the one lane bridge arch on Big Spring, and where the water comes out of the rocks.

Area around the old mill.

Mills and other cultural and environmental sites that are endangered.

Head of spring is unique.

Sites of historic
mills

The ability to drive and see wildlife. The area below the fish hatchery.

It's location - who planned this? Springfield and the Dutch building. We attempted to buy 16 years ago. The authority said no, they had plans for it and now it is falling down.

There was an historic Indian village at the mouth of the Big Spring on the hill along Conodoguinet Creek adjacent to wetlands.

Suggested Improvements (Total Responses: 10)
I would like to see better upkeep o the area near the hatchery. Many times the grass is too long and now the water is filled with algae.

Must protect the watershed.

The Big Spring is a beautiful, natural resource and plays an important part to many people living along or near the water. It should be kept as close to the way it is as possible with only water quality and anti-development kept in mind.

Fix the wooden wheel to make it complete.

Put more picnic tables along the creek, especially in the parking areas.

Continued fly fishing and maintaining aquatic habitat for trout and other species in the food web.

Finish the bike trail between Shippensburg and Newville.

I especially like the head water area when the water comes out of the cliff. I used to walk up the hill and look down on the spring from the huge trees there. I would like you to bring out the Indian presence in the head water area a they thought it a special place.

Keep and/or restore the creek to a natural creek with limited amount of intrusions.

Protect rural character by controlling development. Increase interpretation of historical and environmental aspects for visitors via signage along Big Spring.

Negative Comments (Total responses: 2)

I used to like driving by and looking at the spring but now it is really low and not worth looking at.

People used to come from out of state to fish one of the finest creeks in the country. The water has gotten bad, and there are no hatches for the avid fly fisherman. Improvements to the spring can help tourism and Newville's economy.

Question #7 Please share any projects, studies or efforts underway that may have an impact on the Big Spring and its watershed (Total responses: 33):

Concern about the rock quarry recently opened and land development.

Fox development of former McCullough farm.

Save the railroad culvert over the spring.

Appreciate what watershed association is doing to reclaim the creek and hope they get all public and private funding possible.

Restore brook trout population, spawning area needs.

See BSWA website.

The restoration of the Cooperage and creation of a visitor center with learning opportunities. It would be helpful to develop a series of fact sheets that educate everyone about how to protect, preserve and use the great resource (2).

Farmers are cutting trees to have more soil to plant. This will increase erosion. People cut plants and mow up to the creek, denying shelter to wildlife.

The water level has dropped dramatically in the last year. I have no idea why.

All the horrible developments, expansion of Green Ridge Village

Remove all dead wood out of the stream, most importantly adjoining the Presbyterian home Green Ridge property.

Do not know any at this time.

A park was planned on Green Ridge Village stream property but not accomplished due to GRV's

reluctan
ce.

Concerns about dropping water levels.

Chesapeake Bay stops the natural free flow of water.

Get the water level back up

Cleaning the spring is a good idea but it will not make it deeper or wider. Put small dams in some places.

Appreciate what interested sportsmen have done over the years.

Cut away the dead parts in the cat of nine tails area so the new growth will look better.

Impact of the constant building and extensions of area at Green Ridge retirement home. We don't favor that at
all.

USGS and Trout Unlimited projects

I think things should have been left naturally. We live less than two miles away.

Parts of the stream are overly wide and heavily silted from past history of compoundment, acquisition of adjoining lands are needed including land within areas of ground water infiltration.

Why do they continue to put all those rocks in the stream. They look awful and take away from the natural look.

The quarry on Jacob's lane.

All the mud and silt needs to be cleaned out so that there is a channel and spawning area for fish to reproduce.

Negative impact of the quarry.

Big Spring clean up - making sure there is no trash in the spring.

The impact of more development in the
area.

I initiated the senior class at Big Spring High School in 1990 to have an annual spring clean up. It went well the first couple of years, but I don't know if still going on.

This isn't my area of interest or hobby but I sure appreciate the naturalness of the spring and the hard work others do to keep it clean.

Big Spring Farm Wetlands (U.S. easement) of about 300 acres is located at mouth of Big Spring.

Any clean up efforts, closing the hatchery was great. We hope not the quarry.

Weed beds growing back between Laughlin Mill and the medical center.

Bridge repair at Neary Road.

It is a valuable natural resource that needs to be preserved with access improved without turning it into a park.

Question #8 Do you have any other comments to share? (Total responses: 54)

General Comments

Big Spring creek is a huge asset to this area. It should be monitored and protected.

Careful consideration should be given to any drastic environmental modifications made to the watershed.

Thank you for all that you are doing to protect this wonderful watershed and stream (2).

Big Spring has finally managed to survive, first, a private hatchery, and second, a state hatchery. It now has a chance to develop and maintain its promising potential and I wish you every success in accomplishing that worthy goal.

Easements

We are old and not in very good health but we love the area and enjoy visiting it. We are 86 and 85.

This stream is a national treasure and deserves to be protected/one of the most beautiful places in Cumberland County (3).

I think the BSWA is doing a great job. Maybe you can get the middle school and high school faculty to become involved so they can bring their student resources to help (2)

The delicate beauty of this valley is another aspect that we should work to preserve. It's just a matter of time before the encroachments of modern day development are knocking at the door here/quarry concerns (3)

Its always been the Big Spring. That creek bit is like a fingernail on a blackboard. Those signs give me higher blood pressure. I try not to see them. I hope that little stone building up by the bridge at the bottom of Springfield hill is preserved. It may have been a barrel factory.

I think it is ridiculous that people are trying to make it an all brook trout stream. It never was an all brook trout stream. Brook trout do no grow in the Big Spring like rainbows and brown trout do.

There is so much silt (an other non-natural debris) in it. Nature used to permit the flow of water but man made dams stop it. They should be opened periodically. The Chesapeake Bay agencies should not dictate river policies. Low water flow/siltation concerns (9)

Kids cruelty (throwing stones) and disruption of wildlife while nesting.

I am disappointed over the arrogance and unneighborly ways of the folks that are cleaning the litter from the stream. They have not been good representatives of your organization. They are not welcome on my land that borders the Big Spring.

There are no walking or biking paths and it's too dangerous on the road for any of these activities.

I am the librarian at John Graham Library in Newville and I am willing to do, display, or whatever you need to get to the public.

Stream smells good again since fish waste isn't being dumped in it, that's good.

I live right next toe Laughlin Mill . I was very upset when the trees (old and new), not causing problems were cut down. The willow tree was especially beautiful. A building can be fixed if a tree comes down on it, but it takes one hundred years to "build" a great tree.

I wish Newville Borough didn't allow the mill area of the spring to become so tacky and cluttered with signs, markers, flag poles, mismatched accessories over the years. The accessories do not blend and deter from the mill and spring.

I walk to the spring every day. It is a very peaceful place and I hope it can stay that way. I would like to see more birds return.

I have witnessed muddy runoff water entering the spring during heavy rains from farm fields, erosion, etc. Local landowners need to help prevent this.

I am very concerned about the quarry at Pennsy Supply and how it could have a drastic effect on the water supply of not only the Big Spring but also local wells from homes including ours. Could someone please call me about some information I have about this.

Recommendations

Get rid of the fish hatchery in its entirety. The PA Fish Commission had no business building it at the headwaters in the first place. Subsequently they poorly maintained the facility, resulting in the silting of the stream bed.

Remove all stone wing walls that were placed in the stream in the 1930's. All they do is hold back silt and debris.

Keep development (sprawl) to a minimum. Do not allow construction within a quarter mile of the creek.

We think the spring should be maintained much better than currently. It seems to have become such a mess with fallen trees, piles of rocks, etc. Why? (3)

Keep it natural, keep it wild.

The lower end needs to be opened up, from the mill in town to the Conodoguinet Creek. There is no access.

The dam at the head should be closed and a recreational lake established. Too bad! I am a

47 year resident on the spring.

Mow more grass along it

Maybe something educational, tourist attracting could be developed for fish hatchery building and facilities. Seems wasteful as is.

We need to put two dams back in Big Spring, one at the nursing home for sure like there was before or it will just remain a run. This comes from all the fisherman I talk too.

Head of spring to bait fishing instead of just fly fishing so everyone can enjoy it. Spring cleaned up at sewer treatment plant to the head of the creek entrance. It's filled with silt from the plant (2).

Habitat restoration including removal of sediment, sand from spawning gravel should be a priority.

A hiking/biking trail along the Big Spring would bring more people to the spring to hike or bike. The road along the spring is twisty and narrow making it dangerous for hikers and bikers.

Perhaps a park like area could be developed near Laughlin Mill to satisfy the needs of folks who would
like a park, but I hope the rest of the spring remains/becomes a natural area.

We need a plan to clear the silt from the creek, especially toward Newville.