12/2003 DEP Bureau of Watershed Management

Watershed Restoration Action Strategy (WRAS)
State Water Plan Subbasin 03E
Perkiomen Creek Watershed
Montgomery, Bucks, Berks, and Lehigh Counties

Introduction

This 362-square mile subbasin consists solely of the Perkiomen Creek and its tributaries, which is part of the Schuylkill River basin. The watershed extends from the southern tip of Lehigh County, southeastern Berks County and the northwestern part of Bucks County into the upper half of Montgomery County. A total of 488 streams flow for 636 miles through the subbasin. Major tributaries are the 60.9-square mile East Branch, the 55.8-square mile Skippack Creek, the 55.4-square mile Swamp Creek, and the 48.8-square mile Unami Creek watersheds. The subbasin is included in **HUC Area 2040203**, Schuylkill River, a Category I, FY99/2000 Priority watershed in the Unified Watershed Assessment.

Geology/Soils

The subbasin lies primarily within the Northern Piedmont Ecoregion. The Triassic Lowlands (64a) section comprised of non-carbonate sedimentary rocks of red and brown sandstone, shale, siltstone, and conglomerate of the Brunswick Formation forms most of the base rock. The Triassic Lowlands have intrusion of the igneous rock, diabase, part of the Diabase and Conglomerate Uplands (64b) section, which have baked the adjacent sandstone into arkos sandstone and argillite, called Trap Rock. Rocks are mostly gray or black argillite of the Lockatong Formation (Trap Rock) and diabase, which are quarried as building stone and aggregates. Boulder fields are common. The Lockatong Formation is tightly cemented and has low water well yields unless fractures are encountered.

The topography consists of low rolling hills interrupted by diabase ridges. Streams flowing through diabase ridges, such as the lower half of Unami Creek, are entrenched in steep-sided, diabase boulder-strewn valleys. The Boroughs of East Greenville, Pennsburg and Red Hill lie within a bowl-like lowlands encircled by higher wooded, diabase ridges. Green Lane Reservoir Dam is at the southern end of this lowland and receives runoff from the surrounding hills and upstream valley. The diabase areas are generally wooded and undeveloped because the steep slopes, large boulders and rock outcrops.

The northern and northwestern portions of the watershed in Lehigh and Berks Counties are within the Reading Prong (58h), part of the Northeastern Highlands Ecoregion. Metamorphic and igneous rocks (mainly gneiss and quartzite) form higher hills and ridges through this portion of the subbasin which form the headwaters of main stem and West Branch Perkiomen Creeks and Hosensack Creek. The rocky, hilly nature of this area has limited its use for agriculture and residential development.

A small portion of limestone rock is found in the northeastern part of the basin. A few limestone and dolomite quarries are present in the basin in the very northern reaches in Lehigh and Berks counties. Gray or black argillite and diabase are also quarried as building stone and aggregates throughout the Perkiomen Valley.

High stream flow variability with high flood flows and very low flows are characteristic of the Perkiomen Creek watershed. The soils in the subbasin are complex and have varying infiltration rates. The dominant soil is the less well drained and fairly shallow C; however, B soils that are well drained and allow a reasonable amount of rainfall to infiltrate are also relatively common. Runoff in C soils during storms is significant. High water tables and shallow bedrock limit infiltration. The diabase and Trap Rock areas are resistant to infiltration except through faults, have very poor capacity to store water, and

are, therefore, limited as aquifers for drinking water. Soils in Reading Prong portion are well drained and fine-grained.

Land Use

Many small towns and boroughs are scattered throughout the Perkiomen Valley. The percent of developed area is increasing rapidly as farms are converted into single family and townhouse subdivisions. The upper Perkiomen Creek watershed is still largely rural, with farming the predominant land use. Many woodlots remain in the upper subbasin, especially in the Trap Rock/ Diabase portions. Several high use highways including the northeast extension of the PA Turnpike and U.S. and PA Routes 309, 113, 29, and 100 traverse the watershed. Population of the subbasin was 192,000 in 1990 and is projected to increase significantly to 238,000 by the year 2040. In 1993 the land use was 36% forested, 44% agriculture, and 20% developed.

Natural Resources:

- Evansburg State Park, comprising approximately 3,400 acres, is located along the Skippack Creek in the lower part of the subbasin.
- Several State Game Lands are scattered throughout Montgomery, Berks, and Bucks Counties in the watershed. Although small, they receive a lot of local recreational use.
- The 814-acre Green Lane Reservoir Park in Montgomery County is a very popular recreational area owned by the Philadelphia Suburban Water Co. The reservoir is used as a water supply for over 140,000 customers. Although a privately owned reservoir, it is open to the public for fishing and boating. This reservoir drains 71-square miles of land. The riparian land around the reservoir is owned and leased by the Montgomery County Parks System as a non-contact recreational area.
- The 38-acres Deep Creek Lake, which drains 5.5 square miles of land to the south and west of Green Lane Reservoir, is a popular Montgomery County park, offering a swimming beach and other recreation.
- Knights Lake, a 25-acre reservoir immediately below Deep Creek and Green Lane, also receives flow from Macoby Creek.
- The lower half of Unami Creek north of the Village of Sumneytown is protected by woodland in two Boy Scout Camps, Delmont and Hart.
- Central Perkiomen Park protects a narrow stream corridor for several miles from below Schwenksville to the lower end of Collegeville Borough.
- Lower Perkiomen Park and the Audubon Wildlife Sanctuary near the Village of Audubon protect a portion of the lower end Perkiomen Creek. The Sanctuary connects with the upper end of Valley Forge National Park.
- Naturally reproducing brown trout populations: headwaters of Northwest Branch Perkiomen Creek, upper Swamp Creek, West Branch Perkiomen Creek, and Hosensack Creek.

PA Fish and Boat Commission Class A Trout Waters (highest biomass category):

- Perkiomen Creek, brown trout, headwaters down to SR1010 at Hereford (5.3 miles, Berks and Lehigh Counties)
- Northwest Branch Perkiomen Creek, brown trout, SR1020 down to SR2069 (4.9 miles, Berks County)
- Unnamed tributary to Northwest Branch Perkiomen Creek (near Landis Store), brown trout (2.4 miles, Berks County)
- Swamp Creek, brown trout, headwaters down to dam in Bechtelsville (2.6 miles, Berks County)

Chapter 93 High-Quality (HQ) Stream Listings:

- HQ-TSF: Unami Creek

Water Supplies

Water supply use in the watershed is a mix of private and public systems developed from mostly groundwater sources. Hundreds of individual water supply wells are located throughout the subbasin. Several mobile home parks, schools, and large industries have their own water supply systems. Agricultural use of groundwater is limited. Reservoirs such as Green Lane Reservoir are also used as water supplies.

Water from the Delaware River drainage is diverted into the Perkiomen Creek watershed via the Point Pleasant diversion project. The water enters the East Branch Perkiomen Creek, which is the eastern-most portion of the watershed.

Water Quality Impairment

Portions of the Perkiomen Creek watershed are impaired by excess nutrients, erosion and sediment from agricultural and small residential development nonpoint sources and municipal point sources. Groundwater contamination and coliform bacteria from malfunctioning septic systems are also serious problems in some areas. Reservoirs in the subbasin experience contamination from bacteria and pathogenic organisms.

Monitoring/Evaluation

The evaluation under the Department's unassessed waters program is underway and will be completed by the end of 2001. Forty-four percent of the watershed had been assessed as of the end of 2000. Assessments have been completed for the Skippack Creek, Swamp Creek, and portions of main stem Perkiomen Creek, (North) East Branch and (North) West Branch watersheds. Out of the 278.8 miles assessed, 57.7 miles or 21% were determined to be impaired. Sources of impairment are small residential development (12%), municipal point sources (8%), and urban runoff/storm sewers (4%). Some stream sections were impaired by more than one pollution source.

Sources of Impairment for Assessed Streams in Subbasin 03E
Based upon data collected through October 2000.

Protected Water Use (Chap.93)	Source of Impairment	Miles Impaired (377 miles assessed)	% Impaired of Miles Assessed	Data Source	Priority
Aquatic Life	Small Residential Runoff	34	12%	303d list	Medium
Aquatic Life	Municipal Point Source	23*	8%	303d list	Medium
Aquatic Life	Urban Runoff/Storm Sewers	11	4%	303d list	Low
Aquatic Life	Removal of Vegetation	4	1%	303d list	Medium
Aquatic Life	Land Development	3	1%	303d list	Medium
Aquatic Life	Agriculture	2	1%	303d list	Medium
Aquatic Life	Unknown	1	<1%	303d list	Low
	Total	370			

* = includes 10 miles of main stem of Perkiomen Creek which was placed on the 303d list based upon cause/effect surveys for sewage treatment plants that since have been upgraded or eliminated. These impaired sections may be delisted in the future.

The majority of the impairment is in the Skippack Creek watershed. Skippack Creek watershed has the poorest quality of any stream assessed so far in subbasin 03E. Towamencin Creek and one unnamed tributary are impaired by discharges from sewage treatment plants and small residential development that

cause excessive blooms of algae and water flow variability. Siltation and water flow variability from small residential developments impair the main stems of Skippack Creek and its West Branch.

Green Lane Reservoir is on the 303d list due to impairment by organic enrichment and low dissolved oxygen (DO) from agriculture. Poor water quality causes degraded fisheries and interferes with the recreational and aesthetic values of the lake. The reservoir serves as a settling basin for runoff from upstream agricultural areas, several boroughs and the surrounding hillsides.

Nearly 11 miles of main stem Swamp Creek and 6 unnamed tributaries are impaired by removal of vegetation and urban runoff. The main stem is also impaired by a municipal point source. The upper 2.6 miles of Swamp Creek has a naturally reproducing brown trout population.

DEP biologists use a combination of habitat and biological assessments as the primary mechanism to evaluate Pennsylvania streams under the Unassessed Waters Program. This method requires selecting stream sites that would reflect impacts from surrounding land uses that are representative of the stream segment being assessed. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment. The length of the stream segment assessed can vary between sites. Several factors are used to determine site location and how long a segment can be, including distinct changes in stream characteristics, surface geology, riparian land use, and the pollutant causing impairment. Habitat surveys and a biological assessment are conducted at each site. Biological surveys include kick screen sampling of benthic macroinvertebrates, which are identified to family in the field, and an evaluation of their tolerances to pollution. Benthic macroinvertebrates are the organisms, mainly aquatic insects, that live on the stream bottom. Since they are short-lived (most have a one-year life cycle) and relatively immobile, they reflect the chemical and physical characteristics of a stream and chronic pollution sources or stresses. Habitat assessments evaluate how deeply the stream substrate is embedded, degree of streambank erosion, condition of riparian vegetation, and amount of sedimentation.

The upper 24.53 miles of the main stem Perkiomen Creek is unimpaired. Portions of the lower main stem are impaired, 9.66 miles by excess nutrients from municipal point sources and 1.45 miles by siltation, nutrients and thermal modifications from agriculture. The lower-most 2.26 miles are unimpaired. Twenty-three miles of the main stem East Branch (Northeast Branch) Perkiomen Creek and one unnamed tributary are unimpaired. Portions of small headwater tributaries of the East Branch Perkiomen Creek, including Pleasant Spring and Mill Creek near Sellersville and Perkasie, experience summer drying. The headwaters of the main stem near Schwenksville also become dry during the summer. The main stem and 15 unnamed tributaries of the West Branch (Northwest Branch) Perkiomen Creek are also unimpaired. The upper main stem and West Branch sections in the Reading Prong maintain the coldest water and the best water quality and have natural reproducing populations of brown trout. The main stem Perkiomen Creek downstream of Green Lane Reservoir was downgraded from trout stocked fishes (TSF) to warm water fishes (WWF) in 1986 due to its inability to maintain a stocked trout population.

Stormwater:
The Perkiomen Watershed had been primarily an agricultural area up until the early to mid 1980's. After this time a large number of farms were subdivided and turned into housing developments. Land clearing and residential construction increases the amount of impervious surfaces (roads, parking lots, driveways, houses). Stormwater associated with development impacts both the quantity and quality of water entering streams. Sedimentation associated with increased stormwater runoff adversely impacts aquatic life and habitat. Settled sands, silts and clays reduce macroinvertebrate habitat by filling interstitial areas between larger streambed substrates. This loss of invertebrate habitat can cause a reduction in productivity and community diversity. Suspended silts and clays can reduce light needed by periphyton, interfere with foraging success of sight and filter feeders, and interfere with oxygen transfer (clog gills). Additionally,

storm event scour by suspended sands and silt can reduce productivity and diversity of periphyton and macroinvertebrate communities.

Municipal Point Sources:
Municipal wastewater treatment plants serving concentrated population centers within the watershed discharge treated effluent containing significant amounts of nutrients. Indian Creek, Towamencin Creek and Perkiomen Creek are listed for municipal point source impairment caused by nutrients, organic enrichment/low DO, excessive algal growth and water/flow variability, although the treatment plants on the main stem Perkiomen have either been upgraded or taken off line. While municipal point sources are regulated under the state administered federal NPDES program, large treatment facilities on small watersheds overwhelm the streams capacity to assimilate treated effluent. Wastewater treatment facilities in the upper Perkiomen basin have discharge limits for phosphorus, however, instream phosphorus concentrations are well above expected ambient concentrations.

Nutrients can adversely impact aquatic life. Increasing nutrient associated with treated sewage effluents can cause excessive algal growth, alter periphyton community composition, and cause diurnal dissolved oxygen swings with low dissolved oxygen (DO) during times when photosynthesis is not occurring. Low DO's associated with high algal standing crop and changes in algal communities will alter fish and macroinvertebrate populations.

Urban Runoff / Storm Sewers:
Many pollutants are deposited or placed on impervious areas and urban/suburban landscapes (lawns, golf courses, athletic fields). These pollutants include animal feces, oil, fertilizers, pesticides, anti-freeze solution, and solids. These pollutants discharge directly to the stream in developed areas that lack stormwater pollution controls (infiltration areas, vegetated detention basin, retention ponds). Increasing the frequency of bank-full storm events and overall storm flows causes bank destabilization, increased sediment load, increased scour, increased substrate embeddedness, and increased sediment deposition. Channels can widen or deepen causing a loss or alteration of aquatic habitat. All of these stormwater impacts adversely affect aquatic life. Hydrologic modifications associated with stormwater are important causes of aquatic use impairment in the watersheds.

Pollutant loadings associated with stormwater quality can cause stream eutrophication and increase sedimentation and embeddedness. Chemical parameters associated with stormwater have not been extensively sampled in the watersheds and the magnitude of their effects are poorly understood.

Agriculture:
Agriculture impairments impact Green Lane Reservoir and small portions of the main stem Perkiomen Creek and the West Branch Perkiomen Creek. Crop and animal production can adversely impact aquatic life. Erosion of topsoil and runoff of applied manure or chemical fertilizers contribute to stream sedimentation and nutrient loading. Barnyard runoff of manure and proximity of livestock to the stream can also contribute to nutrient loading and sedimentation (bank destabilization) respectively. Agricultural best management practices are voluntary and little regulation exists for reducing pollutant loads from agricultural areas.

The 95-square mile watershed above Green Lane Reservoir includes 18 municipalities in four counties and three reservoirs. The dominant nonpoint sources of pollution are poor agricultural practices, septic system leachate, and runoff from urban and suburban development. The shape and size of the reservoir contribute to cultural eutrophication; impurities and pollutants that enter the reservoir bind to the sediments and become trapped for a long time. The combined effects of the pollution sources are over enrichment of the reservoir and severe algae blooms. Water quality and overall phosphorus loading in the upper Perkiomen Creek watershed has improved since the 1980's as a result of advanced treatment of

municipal wastewater; however, population growth in the watershed could increase phosphorus loadings from municipal waste treatment. The Perkiomen Watershed Conservancy and Perkiomen Valley Trout Unlimited are leading efforts to restore riparian vegetation in the upper Perkiomen Creek watershed which should help reduce runoff from farmlands and other affected lands.

The streams above Green Lane Reservoir are of good quality even though the reservoir itself is impaired by excess nutrients. Reservoirs act as traps or sinks for runoff from the upstream watershed. Depending on the gradient of the upstream creeks, sediments and nutrients may be washed out of the creeks and be deposited in the lake. If the amount of sediment and nutrients are not high enough to severely affect the macroinvertebrates in the creeks, then the upstream creeks will be determined to be unimpaired but the lakes will be impaired by sediment and nutrients that build up in lake bottom sediments and at the shores and adversely affect dissolved oxygen levels in the lake. Since Green Lane Reservoir is at the downstream end of a bowl-like lowland, it receives most of the runoff from the upstream agricultural and urban/suburban land areas and the surrounding hillsides.

Green Lane Reservoir has been reported in numerous reports to have fair to poor water quality conditions. (See reference section for a list of studies on Green Lane Reservoir.). The reservoir has documented fish kills, low plankton diversity indices dominated by pollutant tolerant species, chlorine toxicity, low DO, phosphorus overloads, and high total phosphorus levels. Massive algal blooms, siltation, and excessive nutrients were documented in upstream tributaries. Adverse impacts to the Perkiomen Creek downstream of reservoirs due to the lake bottom (hypolimnion) discharge were also noted. Other documented impacts included hazardous waste incidents of TCE, PCB, DDE, industrial solvents, and elevated nutrients from malfunctioning septic systems, and point sources.

The highly eutrophic Deep Creek Lake has large algal mats and elevated fecal coliform bacteria from on-lot septic systems and an overabundance of Canada geese.

Point Sources / Surface Water:
DEP regulates point source discharges by requiring such discharges to obtain an NPDES permit. NPDES permits establish effluent limits, specify self-monitoring requirements, and require submission of periodic reports known as discharge monitoring reports. The major point sources of pollution are sewage treatment plants, industrial facilities, and "wet weather" sources such as sanitary sewer overflows (SSOs), and storm sewers. Sewage treatment plants treat and discharge wastewater from homes, public buildings, commercial establishments, some storm water sewers, and some industries. Many industrial facilities treat and discharge their own wastewater, either directly to nearby waters, or to sewage treatment plants. No known combined sewer overflow (CSOs) (sewers that combine storm water and sewage in one system) are found in the Perkiomen Creek watershed, but several sewer systems experience overflows due to excessive infiltration and inflow of surface water and groundwater into the sewer lines.

There are 114 facilities covered under an individual NPDES permit that can be classified as point sources. Of these, 24 are municipal plants (publicly owned treatment works) including 2 small flow treatment plants that serve visitors to township parks and one malfunctioning community spray irrigation site that will phase out upon completion of a new plant with a direct stream discharge. An additional 66 facilities are discharges from non-municipal sewage treatment plants, serving mostly school districts, small developments and single family dwellings. These municipal and non-municipal sewage discharges account for approximately 90 % of the total permitted flow for facilities covered under individual permits. Although the permitted loads are higher than what is currently discharged to the watershed, these discharges account for a significant amount of organic and nutrient loads within the basin. As growth continues within the region, most of the municipal plants will reach their capacity and expand as needed to accommodate future population projections. This will result in additional loadings to the watershed, often to the headwaters of streams which are already stressed due to other factors such as reduced

baseflow resulting from increases in groundwater withdrawals and reduced groundwater infiltration which accompanies land development.

The remaining 24 discharges are categorized as industrial wastes ranging from small discharges of non-contact cooling water and discharges from food processing and manufacturing facilities that can include significant organic loads, metals and other toxics that require a high degree of treatment prior to discharge. General NPDES permit have been granted for stormwater discharges associated with industrial activities such as industrial site runoff, construction site runoff, and petroleum groundwater cleanup.

Future threats to water quality

With the high projected population growth, water quality impairments associated with increased urbanization and pavement are expected to increase. These would include erosion and sedimentation from construction, urban runoff from many small municipal areas, and point source discharges from municipal sewage treatment plants. Population growth is expected to have a substantial impact on NPS loads, specifically total phosphorus, oil and grease, and heavy metals. More agricultural land is expected to be converted to suburban development or commercial and industrial use. Future growth also threatens the quantity of water supply sources. Aquifer capacity is limited and groundwater protection plans should be developed to ensure adequate water supplies for the increasing population.

Urbanization and paving can have a severe effect on stream aquatic life. Studies by the Maryland Department of Natural Resources stated that a reduction in stream aquatic species diversity may begin with as little as 2% impervious cover. Maryland streams with above 15% impervious cover were rated fair to poor for aquatic species. When the impervious cover reached 25%, species diversity was significantly reduced. Riparian vegetation removal and paving affect both stream water temperature and habitat for aquatic species. Organisms most affected include many species of reptiles and amphibians, brook trout, and stoneflies. Stormwater runoff from paved areas can also wash out oil and grease and other pollutants into streams. The paved areas also restrict replenishment of groundwater and contribute to flash flooding during storm events and extreme fluctuations in stream water levels. Extreme flow fluctuations cause difficulties in the attachment of bottom dwelling organisms to the stream substrate and also cause a scouring of the substrate. Retention of riparian vegetation in unnamed headwater tributaries, known as first order streams, which may comprise as much as 50% of the streams in a watershed, can be especially critical to the protection of organisms in the downstream watershed.

Restoration Initiatives

Pennsylvania Growing Greener Grants:

- $35,430 (FY2002) to the Natural Lands Trust, Inc. to assess aquatic diversity and address nonpoint source pollution of Unami Creek in Lower Milford, Milford, and West Rockhill Townships and Trumbauersville Borough in Bucks and Lehigh Counties.
- $44,550 (FY2002) to Pennsburg Borough to stabilize streambanks using plantings and bioengineering techniques along three meanders of Macoby Creek flowing through Pennsburg Nature Preserve.
- $14,920 (FY2002) to North Penn School District to remove invasive plants from four wetland areas and along streambanks and replace them with native plants.
- $5,000 (FY2001) to Upper Makefield Township for restoration of riparian buffers on the Meister property.
- $37,555 (FY2001) to the Montgomery County Conservation District for water and manure management at the Sebastian Riding Associates.
- $99,968 (FY2001) to Towamencin Township for restoration and protection of the West Branch Towamencin Creek.

- $7,100 (FY2000) to Perkiomen Valley Trout Unlimited to remove invasive multiflora rose plants and replant the riparian buffer zone along the Perkiomen Creek in the new 14.8-acre Hereford Township Park with native species.
- $134,100 (FY2000) to the Borough of Collegeville for removal of a damaged run-of-the-river dam on Perkiomen Creek. The restoration will allow fish passage and will be accompanied by restoration of the streambanks on an adjoining 16-acre tract.
- $24,433 (FY2000) to Salford Natural Lands Trust, Inc. for streambank stabilization and riparian buffer along 375 feet of Ridge Valley Creek.
- $23,389 (FY1999) to Delaware Valley College to develop a protocol and conduct a survey of the East Branch Perkiomen Creek. Data gathered will be placed in a GIS system and used to prioritize areas for riparian protection or restoration.
- $30,000 (FY1999) to North Penn School District to install riparian buffers along streams and ponds, restore degraded wetland systems and construct a nature trail. An environmental education curriculum for grades 4 through 6 will also be developed for the Gwynedd Elementary School.
- $72,150 (FY1999) to Perkasie Borough to restore over 1,000 feet of eroded streambank in Lenape Park.
- $37,200 (FY1999) to Sellersville Borough to restore 300 feet of severely eroded streambank in Lenape Park.
- $61,000 (FY1999) to Milford Township to evaluate existing water quality and watershed characteristics and to develop model ordinances for municipalities within the Unami Creek watershed. The major sources of nonpoint pollution will be identified and prioritized for restoration.

U.S. Environmental Protection Agency (EPA) Clean Water Act Section 319 Grants:

- $83,655 (FY2001) to Perkiomen Watershed Conservancy to restore the riparian corridor of an unnamed tributary to the West Branch Skippack Creek. The restoration will include planting native species, using bioengineering methods in areas damaged by severe erosion and changing landscape management strategies.
- $61,256 grant (FY1999) to the Perkiomen Watershed Conservancy and the Berks County Conservancy. The project will emphasize riparian restoration and create a public education and outreach program to citizens in the entire watershed. Restoration will be on several farms in Berks County, along an unnamed tributary to the upper Perkiomen Creek in Hereford Township and on a farm along the Northwest Branch of Perkiomen Creek.
- $86,000 grant (FY1998) to Bucks County Conservation District (CD) for restoration of the East Branch Perkiomen Creek. The project will demonstrate vegetative nonstructural streambank restoration to reduce stormwater runoff and erosion on 1,800 feet of stream. Bioengineering and landscaping will be implemented to control the goose population. Riparian vegetation will be restored along eroding banks of the East Branch Perkiomen Creek in Lenape Park in the Borough of Pekasie. Environmental education and volunteer participation will be an important part of the project.

Pennsylvania Watershed Restoration Assistance Program (WRAP) Grants:

- $14,830 (FY1998) to Towamencin Township Municipal Government for riparian restoration using bioengineering techniques and plantings on Towamencin Creek. The restored area will be used as a demonstration area for the township's environmental education program.
- $5,096.75 (FY1999) to Towamencin Township for continuing riparian restoration on the Towamencin Creek in Fisher's Park adjacent to Evansburg State Park. Wetlands planting will be installed next to the riparian corridor to protect and enhance an existing wetland. This project will implement a recommendation of the township's 1997 Towamencin Creek Corridor study.

Nutrient Management Planning:

- Nutrient management planning through the EPA Section 319 program and the Nutrient Management Act (Act 6 of 1993). A technician working for the Bucks County Conservation District covers Bucks, Montgomery, and Lehigh Counties. Most of the agricultural best management practices implementation work so far completed has been in Montgomery County.

- A second technician working for the Berks County Conservation District covers the Berks county part of the Perkiomen Creek watershed under the Nutrient Management Act delegation agreement with the district.

Department of Conservation and Natural Resources (DCNR) Rivers Conservation Grants:

- $80,000 (2000) to the Perkiomen Watershed Conservancy to prepare a comprehensive rivers conservation plan for the Lower Perkiomen Creek watershed.
- $50,000 (1997) to the PA Environmental Council to develop a rivers conservation plan for the upper Perkiomen Creek. Cosponsors are the Upper Perkiomen Watershed Coalition and the Perkiomen Valley Watershed Association.
- $225,000 (1996) to the Natural Lands Trust and The Conservation Fund to develop a regionally based watershed conservation plan for the Schuylkill River basin that can be used to support and assist watershed groups in developing detailed plans at the watershed level.

DCNR Keystone Land Trust Program Grants:

- $500,000 to the Natural Lands Trust to acquire 145 acres adjacent to Fulshaw Craeg Preserve in Unami Hills area of Stalford and Upper Salford Townships.

Pennsylvania Act 167 Stormwater Management Plans:

- East Branch Perkiomen Creek, under preparation
- Swamp Creek, under preparation

Other:

- Schuylkill River Watershed Initiative is supported by the William Penn Foundation
- Chapter 6217 Coastal NPS Program project was initiated in the East Branch of Perkiomen Creek in 1997.
- A watershed task force comprised of the Montgomery County Planning Commission, the Bucks County Planning Commission, Delaware Riverkeeper, and other local partners was organized for the East Branch Perkiomen Creek in early 1998.
- Pennsylvania Association of Conservation Districts (PACD) Grant: The Delaware Riverkeeper received a mini-grant through the PA Association for Conservation Districts.

Citizen/Conservation Groups

- The Perkiomen Watershed Conservancy is a local citizen organization, which was founded in 1964 to protect and conserve the natural resources of the watershed. It does this through environmental education, land conservation and protection, and watchdog activities. The conservancy also holds an ambitious annual spring clean up. In 2000, their aim was to clean up 60 miles of the East Branch Perkiomen, Swamp, and Perkiomen Creeks. More information on the conservancy is available on their website at http://www.pvwatershed.org/.
- Berks County Conservancy
- Schuylkill Riverkeeper
- Perkiomen Valley Chapter Trout Unlimited has sponsored tree planting days for volunteers to restore streamside buffers along the upper Perkiomen Creek. They also sponsor volunteer and landowner appreciation days.
- Upper Perkiomen Watershed Association
- The East Branch Perkiomen Creek Watershed Task Force was organized in 1998.
- Tributary Coldwater Action Council of Berks County (includes many partners)
- The Delaware Riverkeeper oversees a volunteer monitoring program with 10 stations in the upper Perkiomen watershed. Volunteers monitor nitrates, phosphates, algal blooms, sediment problems and note occurrences of wildlife.
- Friends of Branch Creek
- The Heritage Conservancy is a nonprofit organization located in Bucks County, PA, dedicated to the preservation of our natural and historical heritage. They have received grants form DEP and DCNR

for their preservation and conservation activities. They assist local conservation groups in southeastern Pennsylvania in assessment of streams conditions and with other conservation projects. More information is available on their website at http://www.heritageconservancy.org/.

Public Participation/Outreach

Watershed Notebooks

DEP's website has a watershed notebook for each of its 104 State Water Plan watersheds. Each notebook provides a brief description of the watershed with supporting data and information on agency and citizen group activities. Each notebook is organized to allow networking by watershed groups and others by providing access to send and post information about projects and activities underway in the watershed. The notebooks also link to the Department's Watershed Idea Exchange, an open forum to discuss watershed issues. The website is www.dep.state.pa.us. Choose Subjects/Water Management/Watershed Conservation/Watershed and Nonpoint Source Management/Watershed Notebooks.

Funding Needs

The total dollars needed for addressing all nonpoint source problems in the watershed is undetermined. Stream assessments have been conducted and TMDLs will be developed for impaired waters in the subbasin. Watershed restoration plans developed for impaired waters will help determine what Best Management Practices (BMPs) are necessary to reduce pollution sources and provide estimates of restoration needs.

Funding sources available to support the development of site-specific implementation plans and remediation projects that address the sources of water quality impairment include the EPA Clean Water Act Section 319 grant program and the newer Pennsylvania funded Growing Greener program which target reductions in nonpoint source pollution. Pennsylvania has generally placed more emphasis on funding projects slated for implementation on water bodies where TMDLs have been completed or where water quality impairments have been documented.

Restoration Needs

Agricultural conservation plans and BMPs such as, manure handling structures, loafing and pasture management, critical area plantings, contour strip cropping, terracing, grass waterways, field borders, and diversions are needed upstream of Green Lane Reservoir and in other agricultural areas. Other practices that will help restore and protect water quality in low-density residential areas of the subbasin include wetland and riparian zone enhancement, installation of sediment basins to control stormwater runoff, and inspection, rehabilitation and pumping of existing septic systems. County and municipal comprehensive planning and zoning for stormwater control, protection and enhancement of riparian areas, and infiltration structures to replenish groundwater resources are also needed.

Implementation of BMPs for agricultural sources in the impaired areas should reduce nutrients and sediment loadings. Streambank stabilization and fencing should reduce phosphorus and sediment loads in the affected areas. Streambank fencing will keep livestock out of the streams and allow restoration of riparian zones to trap sediment and phosphorus, thus keeping these pollutants from reaching the stream. A reduction coefficient of 75% for nutrients and sediment is reasonable to expect with these BMPs. The 75% reduction in loading from BMP implementation is derived from empirical data from previous studies of BMP effectiveness reported in the literature and used by the Susquehanna River Basin Commission in their efforts to model pollutant reductions that may result from various load reduction strategies.

Nonresidential development, which includes office, industrial, and commercial development, is booming, especially in the lower subbasin. This type of development has a high potential for impacts to surface and groundwater resources due to the massive site grading, removal of vegetation, and large areas of paving for parking lots. Local land use planning should encourage these developments to maintain open space,

reduce unnecessary paving, improve land use standards, and better fit of the design to the landscape contours.

Restoration efforts should be directed towards impaired stream segments and stormwater controls in boroughs and residential and commercial developments, and streambank stabilization and riparian buffer enhancements to decrease runoff and control sedimentation. Installation of additional agricultural BMPs, on-lot septic remediation and goose controls are needed to control excess nutrients in Green Lane Reservoir.

Restoration efforts in the subbasin have been directed by a variety of boroughs and townships, the Bucks County Conservation District, and the Perkiomen Watershed Conservancy with grants provided by U.S. EPA Section 319, Pennsylvania Growing Greener and WRAP. DCNR is providing funding for development of rivers conservation plans.

Stream buffers:
The Heritage Conservancy conducted an analysis of stream 1,200 miles in Southeastern Pennsylvania in 2000. They developed a computerized map of riparian buffer hot spots to help local conservation groups and municipalities target areas for riparian buffer restoration. The project was funded under a grant through the DEP Coastal Zone management and Stream ReLeaf programs. The Perkiomen Creek watershed was one of 4 watersheds studied. The method used was a helicopter fly-over and recording the streambanks with a sky-cam and GPS unit. ARC View GIS maps were produced that show the areas needing buffers. Topographic maps and aerial photos were printed and given to leading river conservation associations. Workshops were also held to explain the results of the study. Maps can be clipped and overlaid on tax parcel maps to determine which landowners to contact about riparian buffer restoration. The maps can be used as a tool to prioritize restoration activities and to track future gains and losses. A total of 624 miles were assessed in Perkiomen Creek watershed. The study showed that 67.7 miles were lacking buffers on one side, 142.8 miles lacking on 2 sides, for a total of 210.5 miles or 33.7 percent of assessed miles without buffers. Data is available through PASDA, the Pennsylvania Spatial Data Access website at http://www.pasda.psu.edu/.

Restoration Plan for Green Lane Reservoir:
Green Lane Reservoir is an 814-acre impoundment located in northwestern Montgomery County, PA, in Marlborough, Upper Frederick and Upper Hanover Townships owned and operated by the Philadelphia Suburban Water Company (PSWC). The reservoir discharges an average of 16.5 million gallons per day into the Perkiomen Creek and supplies drinking water to 140,000 customers in Chester and Montgomery Counties. The reservoir is also the centerpiece of 2338-acre Green Lane Reservoir Park, operated by the Montgomery County Department of Parks. Green Lane Reservoir Park and the adjacent Upper Perkiomen Valley Park receive close to one million visitors annually. The two parks provide an important open space recreational enclave amid a rapidly developing residential area.

The reservoir has had a long history of nuisance algal blooms, reduced transparency and low dissolved oxygen concentrations below a depth of ten to fifteen feet. High sedimentation rates and the associated rooted aquatic plant growth in coves of the reservoir have reduced the surface area available for boating, caused a deterioration of the fishery and resulted in a loss of storage capacity for PSWC. These factors have decreased the quality of recreational uses within the park and increased the cost of supplying drinking water to PSWC customers. Sixteen point sources discharge to the Green Lane Reservoir watershed.

The Green Lane Reservoir and Deep Creek Lake Clean Lakes Phase 1 Diagnostic Feasibility Study completed by F. X. Browne, Inc. (FXB) developed a management/remediation plan for Green Lane Reservoir. Creation of a watershed management organization with representatives of all municipalities

and counties, as well as representatives from citizen, environmental and watershed organizations was recommended to assist the municipalities in the watershed in effectively implementing watershed restoration. A strong educational program should be implemented. The watershed organization should coordinate a monitoring program to provide periodic updates on water quality and quantity improvements from BMPs installed and to recommended revisions to the management plan.

General watershed management principles such as watershed-based planning, impervious cover limits, open space planning, and stormwater management practices should be integrated into new or existing municipal ordinances, comprehensive land-use plans and zoning. Ordinances to effectively minimize excessive earth disturbance, unnecessary tree removal, steep slope development and wetlands impingement should be adopted. A riparian stream corridor buffer ordinance for new and existing agricultural and residential development should be a critical component for reducing nutrient runoff. Existing watershed conditions should be examined in order to identify and prioritize nonpoint sources of concern.

The Clean Lakes Report also calls for the implementation of a wastewater management program consisting of septic system management and wastewater treatment facilities review. The septic system phase should include strict testing, design and permitting requirements, and should include on-going inspections and septage pumping. The performance of all existing wastewater treatment plants should be monitored for proper operation and effluent limit compliance.

The Berks County Conservancy, Philadelphia Suburban Water Company, Perkiomen Valley Chapter of Trout Unlimited, Perkiomen Watershed Conservancy, Upper Perkiomen Watershed Coalition and the Schuylkill Riverkeeper have formed a partnership for implementation of BMPs in the watershed. As of December 2000, about 20,500 feet of streambanks on seven farms in the watershed above Green Lane Reservoir have had BMPs installed, including streambank restoration with bank regrading, coconut fiber log placement, tree plantings, and cattle fencing with stream crossings.

References/Sources of information

- State Water Plan, Subbasin 3, Lower Delaware River. Department of Environmental Protection, July 1983
- USGS Topographic Maps
- 319 project proposals and summaries
- DEP: Watershed Notebooks, Unified Assessment Document, and information from databases and files.
- Map of Draft Level III and IV Ecoregions of Pennsylvania and the Blue Ridge Mountains, Ridge and Valley, and Central Appalachians of EPA Regions III
- Upper Perkiomen Creek Watershed Water Quality Management Study, Cahill Associates, January 1994.
- From the Mountains to the Sea: The State of Maryland's Freshwater Streams. Maryland Department of Natural Resources and U. S. Environmental Protection Agency. EPA Publication. EPA/903/R-99/023. 1999.
- Baseline Assessment of the Condition of State Water Plan Watershed Perkiomen Creek (3E). 2001. DEP Southeast Regional Office Environmental Futures Team.

Studies conducted on Green Lane Reservoir or its tributaries:

- A Phase I Diagnostic-Feasibility Study was completed for the Green Lane Reservoir in Montgomery County in 1995 under the Clean Lakes Program (Section 314 of federal Clean Water Act).
- U.S. EPA Eutrophication Study, 1975, the first major evaluation of Green Lane Reservoir and its tributaries, documented water quality conditions, severe algae blooms, and high phosphorus levels.

- PA DER sampled the reservoirs and tributaries on numerous occasions (1974 (2), 1976, 1977(2), 1978(2), 1979(3), 1982 (5), 1983, 1984, 1986, 1987, 1988, 1990, 1992 (2).
- DEP, Southeast Region biologists conducted a Trophic Status Survey of Green Lane Reservoir in 1994
- Cahill Associates study of the Upper Perkiomen Creek Watershed Water Quality Management Study was published in January 1994.
- PA Fish and Boat Commission sampled 1984 and 1992
- PA Suburban Water Company (1992, two reports on water quality)
- F. X. Browne Assoc. report (1983)
- Montgomery Co. Parks study (1987-1992)
- The Wyatt Group study (1991)

Streams in Subbasin 03E: 303d/305b Listings

Stream	**Stream Code**	**Drainage area square miles**	**Miles Attained**	**Miles Impaired**	**Sources/Causes/ *Comments***
3-**Perkiomen Creek**	01017	362	24.53 upper & middle main stem; 2.26 lower main stem; All of 13 UNTs	9.66 lower main stem 1.45 lower main stem	Organic enrichment/low DO/nutrients from municipal point source Nutrients, siltation, thermal modification from AG *Class A brown trout, upper 5.3 miles (Berks & Lehigh Counties)*
4-Hosensack Creek & 6 UNTs	01473	18.0	All		
5-Indian Creek at Hosensack Station & one UNT	01477	4.56	All		
4-Molasses Creek at Perkiomen Heights	01466	2.34			
4- (North) West Branch Perkiomen Creek & 15 UNTs	01439	28.8	All		*Class A brown trout, upper 4.9 miles & upper 2.4 miles of the unnamed tributary near Landis Store (Berks County)*
4-Macoby Creek & 2 UNTs	01413	17.4	All		
5-Macoby Creek Branch & 3 UNTs	01431	3.22	All		
5-Stony Run & one UNT	01427	3.22	All		
4-Deep Creek & one UNT	01411	5.70	All		
4-**Unami Creek**	01362	48.8	** 2.08 main stem		*HQ-TSF*
5-Licking Creek	01398	3.59			
5-Molasses Creek at Trumbauers-ville	01394	3.40			
5-Schmoutz Creek	01392	3.79			
5-Butter Creek	01388	4.35			
5-Hazelbach Creek	01387	2.15			
5-Ridge Valley Creek	01365	11.1			
4-Swamp Creek	01309	55.4	13.62 main stem & 9.07 of 5 UNTs	5.08 main stem; 5.89 of 6 UNTs	Flow alterations, siltation, water/flow variability from Removal of vegetation & urban runoff/storm sewers *Class A brown trout, upper 2.6 miles*
5-Middle Creek	01334	4.49	7.14 main stem & 2 UNTs		
5-Schlegel Run & 4 UNTs	01328	5.76	All		
5-Minister Creek & 4 UNTs	01320	8.29	All		
5-Scioto Creek &	01313	4.50	All		

Stream	**Stream Code**	**Drainage area square miles**	**Miles Attained**	**Miles Impaired**	**Sources/Causes/ *Comments***
one UNT					
5-Goshenhoppen Creek	01310	2.57			
4-Mine Run at Schwenksville & 4 UNTs	01304	4.07	All		
4-**(North) East Branch Perkiomen Creek**	01168	60.9	23.14 main stem; 0.59 one UNT		
5-Morris Run	01277	7.01			
5-Pleasant Spring Run	01248	9.11	All of 4 UNTs		
5-Mill Creek	01233	5.00			
5-Vaughn Creek	01205	1.37			
5-Indian Creek at Harleysville	01181	7.01		**1.21	Salinity/TDS/chlorides from municipal point source
4-Lodal Creek	01153	5.08			
5-Landis Creek	01154	2.59			
4-Schoolhouse Run	01145	3.18			
4-Doe Run	01122	1.41			
4-Skippack Creek	01024	55.8	All of 18 UNTs	15.46 main stem; 6.71, 8 UNTs	Excessive algal growth & siltation from small residential development
5-West Branch Skippack Creek	01083	5.37		4.17 main stem	Siltation & water/flow variability from small residential development
5-Towamencin Creek	01066	11.1		5.62 main stem & 1.06 of one UNT	Excessive algal growth and water/flow variability from municipal point source & small residential development
5-Zacharias Creek	01048	8.2			
4-Mine Run at Audubon	01018	3.11			

Streams are listed in order from upstream to downstream. A stream with the number 2 is a tributary to a number 1 stream, 3's are tributaries to 2's, etc. Delaware River=1, Schuylkill River=2.

UNTs= unnamed tributaries; AG= agriculture

Chapter 93 information: EV= Exceptional Value; HQ= High Quality; WWF= warm water fishes; CWF= coldwater fishes; TSF= trout stocked fishes

Green Lane Reservoir is on the 303d lake list for organic enrichment/low DO from agricultural sources.

The evaluation of this watershed under the unassessed waters program has not been completed.