Updated 5/2004

**Watershed Restoration Action Strategy (WRAS)**
**State Water Plan Subbasin 07B**
**Conodoguinet Creek Watershed**
**Franklin and Cumberland Counties**

## Introduction

The 524-square mile Conodoguinet Creek watershed drains the northern two thirds of Cumberland County and the upper third of Franklin County and flows into the Susquehanna River at West Fairview across from the city of Harrisburg. The subbasin consists of 682 relatively small streams, many of which are unnamed tributaries. The subbasin contains 838 stream miles. The largest tributary watersheds are Middle Spring Creek with a 47.7 square mile drainage basin and Muddy Run at 42.1 square miles. All the other tributaries have drainage areas less than 25 square miles. The subbasin is included in **HUC Area 2050305**, Lower Susquehanna River, Swatara Creek, a Category I, FY99/2000 Priority watershed in the Unified Watershed Assessment.

### Geology/Soils

The majority of the subbasin is in the Ridge and Valley Ecoregion. Blue (North) Mountain forms the northern border in both counties and South Mountain forms the southern border in Franklin County and southwestern Cumberland County. The limestone valley in the lower half, the shale ridges in the northern half of Cumberland County, and the long, narrow ridges and valleys in the Franklin County portion, result in an unusual drainage pattern and watershed outline. The upper third of the Conodoguinet Creek watershed is constricted between Blue Mountain and Kittatinny Mountain in a narrow, forested, low gradient valley, called Horse Valley, which resembles a tail. Small, high gradient tributaries originate on the ridges in the tail portion. Farther east, Blue Mountain is twisted into a large, steep fold called Doubling Gap and a smaller fold just east called McClures Gap.

North Mountain and the western tail of the watershed are in the Northern Sandstone Ridges section (67c). Ridges are comprised of sandstone and the narrow valleys a mixture of limestone and shale. The largest tributary is the southwest flowing Trout Run, which flows between Blue and Kittatinny Mountains and under the Pennsylvania Turnpike between the first and second tunnels. The upper Conodoguinet Creek flows adjacent and parallel but in an opposite direction to the West Branch Conococheague Creek which flows in a narrow tail-shaped valley of its own between Kittatinny and Tuscarora Mountains. These opposing flows seem to be reversed, the Conodoguinet Creek originating far south and flowing north into the Susquehanna River basin and the West Branch Conococheague Creek originating far north and flowing south into the Potomac River basin.

The southern slope of Blue Mountain and most of the northern half of the Cumberland County are in the Northern Shale Valleys section (67b). This portion is comprised of shale interbedded with limestone and dolomite of the Martinsburg Formation. This hilly area of parallel ridges and valleys has many small southeasterly flowing tributaries. The hilly terrain, rocky soils and slow infiltration rates make this section less suitable for farming than the southern half of the subbasin. The soils are shallow, fine grained and rocky with very slow or poor infiltration rates. The shale weathers into fine clay that compacts readily and water table levels are often close to the surface. Groundwater has very high hardness and as a high iron content. Groundwater moves laterally through the shale before reaching the stream channels as baseflow. Riparian vegetation in the shale area provides filtering capacity for removal of pollutants such as nitrates from the groundwater before it reaches the streams.

The middle Cumberland County and eastern Franklin County portions of the subbasin are in the Northern Limestone/ Dolomite Valleys section (67a). This wide limestone valley, known as Cumberland Valley, forms a topographically low southern divide with the Yellow Breeches Creek and Conococheague Creek watersheds. The northern subbasin divide is a typical high relief surface and topographic divide with many surface streams. The southern divide has very few surface streams since most of the flow in the limestone valley is subsurface except for several large northerly flowing limestone spring creeks. Most of the surface and subsurface flow has been captured from the Yellow Breeches Creek watershed, which has no tributaries originating in the limestone valley. Up to 10% of the groundwater that would normally flow into the Yellow Breeches Creek is funneled into Big Spring Creek, which is one of the ten highest volume springs in the state.

The carbonate-derived soils are excellent for farming; however, infiltration rates are slow except at faults and sinkholes. Depressions and sinkholes are especially noticeable in the limestone karst terrain of western Cumberland County.

Most of the groundwater flow in the limestone valley is through faults. Diabase dikes extending north/south through the valley also act as groundwater dams and diversions. Many of the spring creeks discharge at faults or where these diabase dikes cross the valley. The springs are not only conduits for groundwater flow but can also readily channel pollutants and contaminants, such as nitrates and pesticides, through the valley and discharge away from the pollution source. Water entering the groundwater system in the limestone valley quickly moves into the regional aquifer and has little contact time with riparian vegetation for potential removal of contaminants before entering stream baseflow.

The middle-southwest portion of the basin is in the Blue Ridge Mountains Ecoregion, Northern Sedimentary-Metasedimentary Ridges section (66b), called South Mountain in Pennsylvania. The northern portion of the mountain is comprised mainly of sandstone and quartzite, with areas of rhyolite, the southern portion of conglomerates, and metamorphosed igneous rhyolite, basalt, and greenstone schist. Rocks and soils derived from sandstone and quartzite are poorly buffered and susceptible to acid precipitation. The igneous rocks provide better buffered water with higher pH and alkalinity that are not as readily impacted by acid precipitation. The majority of the creeks in the northern half of South Mountain flow to the Yellow Breeches Creek; however, Thompson Creek and Reservoir Hollow originate on South Mountain flow into the Conodoguinet Creek watershed. South Mountain contains low-grade iron ore that was once mined for use in local iron furnaces. Many former ore holes are scattered through the foothills of South Mountain are now visible as water filled depressions. Manganese ore was also mined on the mountain many years ago.

Land Use

The geology and topography play an important role in the land use of the subbasin. A relatively large percent (28.4%) is still forested, but the majority of the forested acres are in the mountainous portions of the upper watershed in Franklin County, in northern Cumberland County on the steep slopes of Blue Mountain, or on the northern flank of South Mountain. The forested areas are mostly state-owned, with scattered houses and camps. The middle half of the subbasin is largely agricultural and the rural lower quarter contains the West Shore suburbs of metropolitan Harrisburg. A total of 61.3% of the watershed is in agricultural land use, with 38.6% in cropland and 22.7% in hay/pasture.

The subbasin is a booming population area due to the nearby state capital across the Susquehanna River in Harrisburg, interstate highways, and recreational lands. Major population centers are located in and around Camp Hill, Carlisle, Mechanicsburg, and Shippensburg. The proximity to major highways has made the subbasin a major stop over and warehouse center for the trucking industry. Two major divided highways pass through the subbasin, the north/south I-81 and the east/west Pennsylvania Turnpike (I-76). U.S. Route 11 (Harrisburg/Carlisle Pike) that parallels I-81 contains many truck stops, strip malls, car dealerships, shopping centers, and other development along most of its length. A total of 161,000 people resided in the basin in 1990; this total is projected to increase to 190,000 by the year 2040.

The limestone valley has numerous farms taking advantage of the productive limestone soils and flat topography. The percent agricultural land use in the watersheds of the limestone spring creeks is high; the highest is 92.9% in Bulls Head/Green Spring Creek watershed. The northern shale valley and mountain foothills also have some farms, but soils are very stony and are not as productive as the limestone soils and the terrain is much hillier than in the limestone valley. Much of shale belt below Blue Mountain contains woodlots, scattered rural houses and villages, and more recently, housing developments. Agricultural lands are rapidly being converted to housing developments in the lower and middle portions of the subbasin.

| **Percentage Of Cropland and Hay/Pasture Land in Conodoguinet Creek Watershed** | | | | |
|---|---|---|---|---|
| **Watershed** | **Area (acres)** | **% Cropland** | **% Hay/Pasture** | **% Agricultural Land** |
| Subbasin Total | 324,366 | 38.6% | 22.7% | 61.3% |
| Rowe Run | 12,056 | 53.7% | 35.2% | 88.9% |
| Middle Spring Creek* | 5,159 | 44.9% | 35.9% | 80.8% |
| Mains Run-Gum Run | 4,704 | 27.0% | 12.6% | 39.6% |
| Paxton Run | 4,674 | 45.2% | 31.2% | 76.4% |
| Clippingers Run | 2,868 | 39.3% | 30.7% | 70.0% |
| Newburg Run | 3,652 | 33.8% | 33.4% | 67.2% |
| Bulls Head-Green Spring* | 17,225 | 61.3% | 31.6% | 92.9% |
| Center Run/Back Run | 4,222 | 32.9% | 34.2% | 67.1% |
| Mount Rock Spring Creek* | 15,784 | 58.3% | 29.1% | 87.4% |
| Alexanders Spring Creek * | 12,273 | 58.9% | 25.6% | 84.5% |
| Wertz Run | 3.667 | 30.3% | 18.0% | 48.3% |
| Hogestown Run* | 11,359 | 56.3% | 31.0% | 87.3% |
| Trindle Spring Run* | 11,405 | 44.8% | 21.3% | 66.1% |

*= Limestone Spring Creeks

<u>Natural/Recreational Resources</u>:

- Doubling Gap State Park and Tuscarora State Forest are located on top of Blue Mountain in western Cumberland and the northern tip of Franklin County.
- Michaux State Forest on South Mountain in western Cumberland County
- State Game Lands #230, north of Carlisle and #169 near Newville in Cumberland County.
- Buchannon State Forest and State Game Lands #235 & #76 in Franklin County.
- Letort Park in Carlisle Borough.
- The PA Fish and Game Commission owned Opossum Lake in northern Cumberland County.
- Letort Spring Run which originates south of Carlisle is a famous trophy brown trout stream which attracts anglers from throughout the world.

Water supplies:

- Reservoirs for the Borough of Shippensburg are located on the Conodoguinet Creek and Trout Run upstream of the borough of Roxbury in Franklin County.
- Conodoguinet Creek has several water supply intakes for Carlisle and West Shore suburbs.
- Shippensburg Borough has water intakes on South Mountain.

PA Fish and Boat Commission Class A (highest biomass category) trout streams:

- Bear Valley Run, headwaters to mouth, brook trout (3.7 miles)
- Big Spring Creek, source to old Thomas Dam, brook trout (0.6 mile)
- Letort Spring Run, Letort Spring to southern edge of former Carlisle Borough sewage treatment plant outfall, brown trout (3.6 miles)
- Trindle Spring Run, spring source near Silver Spring Meeting House to mouth, rainbow trout (0.9 mile)

DEP Chapter 93 designated Exceptional Value (EV) and High Quality (HQ) Streams:

EV:

- Trout Run, source to water supply dam
- Big Spring Creek, source to SR3007
- Letort Spring Run, PA 34 to Letort Park Railroad bridge

HQ:

- Conodoguinet Creek, source to Letterkenny Reservoir Dam
- Doubling Gap Creek, source to PA 944
- Opossum Creek, source to PA Fish and Boat Commission dam (Oppossum Lake)
- Letort Spring Run, source to PA 34

**Water Quality Impairment**

Agriculture and urban/stormwater nonpoint sources, construction, and municipal sewage treatment plants affect the subbasin. The major truck stops and storm sewers in and around Carlisle have degraded Letort Run as it passes through town. Agricultural runoff is the major problem in several tributaries of Conodoguinet Creek upstream of Carlisle in both Cumberland and Franklin Counties. The limestone spring streams, with the exception of the upper Letort Spring are degraded by excess nutrients, especially nitrates from agricultural activities.

Many of the limestone valley springs and spring runs experience stream dewatering during part of the year. Two of these, Alexander Spring and Mount Rock Spring, lose water in their lower reaches and often stop flowing into the Conodoguinet Creek during summer and fall. Mount Rock Spring often loses flow in its upper end. Trindle Spring has little or no consistent flow in its upper reaches until the confluence of the large spring in its middle reaches called Silver Spring. The flow of Big Spring Creek at its source has also become reduced. Water withdrawn for use as drinking or irrigation water is often not returned to the land, but is often discharge into the streams. Most of this water is then lost for recharge into the groundwater.

Monitoring/Evaluation

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.

Seventy-one percent of the subbasin was inventoried under the Department's Unassessed Waters Program in 1997. Originally, 84.17 miles of the main stem and unnamed tributaries of the Conodoguinet Creek were found to be impaired from downstream of Roxbury to the confluence with the Susquehanna River. However in 2004, the main stem Conodoguinet Creek was resurveyed and taken off the 303d list and is no longer considered impaired. All 105 miles from source to the Susquehanna River are now designated as attaining aquatic life use. The main stem was improperly classified as impaired on earlier DEP 303d lists. Unfortunately, several tributaries are still impaired by excess siltation and organic enrichment from agricultural activities, construction or urban runoff.

The tributaries Rowe Run, Middle Spring Creek, Gum Run, Paxton Run, Clippingers Run, Newburg Run, Whiskey Run, Bulls Head Branch, Big Spring Creek, Mount Rock Spring Creek, Alexanders Spring Creek, Wertz Run, Letort Spring Run, Hogestown Run, and Trindle Spring Run were determined to be partially or totally impaired. Eleven unnamed tributaries were also determined to be impaired by siltation, nutrients, organic enrichment from agriculture or removal of vegetation or by habitat modifications or flow alterations. One mile of Letort Spring Run is impaired by urban runoff/storm sewers or other habitat alterations.

Sources of impairment in the Conodoguinet Creek watershed were identified as agriculture, land disposal, habitat modification, construction, and urban runoff/storm sewers. The 303d list states that much of the impairment is caused by nutrients and organic enrichment/low dissolved oxygen (DO); however, DO is not measured directly. Organic enrichment is often determined by the presence of extensive algal blooms, which are assumed to contribute to low DO, and the absence of pollution sensitive aquatic species.

Construction was also named as a major source of impairment. Truck and storage terminals and commercial development are expanding the paved areas around the Boroughs of Carlisle and Mechanicsburg and along the Harrisburg/ Carlisle Pike (U.S. Route 11). The Cumberland County portion of the main stem has a narrow riparian buffer along much of its length, but soil erosion is extensive enough to cause the Conodoguinet Creek to run high and muddy after every moderate to heavy rainfall. The spring creeks originating in the limestone valley have generally suffered more degradation from the surrounding agricultural and suburban land uses than their more rural or forested shale-based counterparts. The spring creeks have also experienced loss in water quantity.

Thirty-six point source facilities discharge into the Conodoguinet Creek watershed. Eight of these discharges, Letterkenny Army Depot Industrial Waste Water, Shippensburg Borough Authority Sewage Treatment Plant (STP), Pennsylvania Fish and Boat Commission Big Spring Fish Hatchery, Carlisle Borough STP, Mechanicsburg Borough Municipal STP, two Hampdon Township STPs, and the East Pennsboro STP, contribute significant amounts of nitrogen or phosphorus to the watershed. These eight dischargers and their locations and discharge streams are listed in the TMDL section of this WRAS. The older portion Cumberland County landfill located east of Newburg Borough emits seeps of degraded water to the Conodoguinet Creek.

The Cumberland County Conservation District completed a watershed assessment and an estimate of costs of agricultural nutrient and sediment controls under the Chesapeake Bay Program in the early 1990's. The District has gained the cooperation of many farmers and landowners for the installation of agricultural best management practices (BMPs). Many farmers in the watershed have participated in incentive programs for nutrient and animal waste management and conservation planning. Financial and technical assistance for planning and implementation of BMPs has been provided through the Conservation Districts and the US Natural Resource Conservation Service (NRCS) EQIP program; however, the EQIP program has lost most of its funding. Applications for grants to control sediment and nutrient runoff in the watershed should be a major goal of the conservation districts and watershed associations.

The Letort Regional Authority maintains a network of 10 water sampling sites on Letort Spring Run. Water samples are collected every month at all sites and every other week at 2 sites, one above Letort Park and one at the mouth. Parameters tested are dissolved oxygen (DO), pH, temperature, total dissolved solids, turbidity, nitrate-nitrogen, and phosphates. Flow is recorded at a USGS gage station near the mouth. Dr. Candie Wilderman of Dickinson College has also conducted several studies on the Letort, one of which was a 1993 study of the effects of stormwater runoff from the Borough of Carlisle. Water and sediment samples were analyzed for heavy metals and several inorganic parameters. Brown trout and white suckers flesh were also analyzed for heavy metals. Results showed that metals concentrations were elevated in the Letort Spring from stormwater runoff pipes that flow directly into the stream as it passes through Carlisle and from pavement runoff from the Middlesex Township truck stops east of Carlisle.

Volunteers from the Conodoguinet Creek Watershed Association are monitoring water quality at over 20 locations in Cumberland County and in the Shippensburg Borough area. Parameters measured include dissolved oxygen, nitrates, and phosphates. The Alliance for Aquatic Resource Monitoring (ALLARM) is coordinating quality control and management of the data collected. Two Shippensburg University professors and their students restored Burd Run, which flows through the campus and a local park, through a Growing Greener grant.

Future threats to water quality

Increasing urbanization and traffic on the interstate highways will expand the urban runoff problems in the watershed. The location of I-81 and PA Turnpike exits and corridor make the subbasin one of the major truck stop and trucking terminal areas in the east. Urban and stormwater runoff problems are having an impact on the limestone streams in the valley such as the Letort Spring Run and Alexander Spring. Suburban housing growth in the watershed is increasing rapidly as more people move to this desirable area. The agricultural lands in the valley are being replaced with housing developments and new businesses. The area to the south of the Conodoguinet Creek generally consists of limestone soils while the area north of the creek is shale land. These two areas have a markedly different impact on groundwater resources, especially in the agricultural and urban areas. Increasing development and water withdrawal for individual on lot wells has the potential to lower the groundwater table and dewater additional segments of limestone spring streams in the valley.

**Restoration Initiatives**

Pennsylvania Growing Greener Grants:

- $50,000 (FY 2003) to Cumberland Valley Chapter of Trout Unlimited for restoration of Letort Spring Run.
- $102,000 (FY2002) to the Letort Regional Authority for investigating aquifer and geologic hazards in the Letort Spring watershed.
- $81,000 (FY2001) to Silver Spring Township for restoration of riparian buffers at Willow Mill Park along the Conodoguinet Creek.

- Cumberland County Conservation District (FY2001):
  - $7,500 for formation of the Big Spring Watershed Association.
  - $63,712 for agricultural BMPs for the Mount Rock Spring watershed.
  - $33,712 for agricultural BMPs for the Bore Mill Run Watershed.
- $202,997 (FY2001) to the Franklin County General Authority for development of the Letterkenny Industrial Development Authority wetland/stormwater treatment facility.
- $35,000 (Fy2001) to Cumberland Valley Chapter of Trout Unlimited for assessment and restoration of Big Spring Creek using fluvial geomorphological (FGM) metjods.
- $129,000 (FY2000) to the Cumberland County Conservation District for the Burd Run project, which will relocate the stream channel, increase aquatic habitat by 8500 square feet, stabilize e 1200 feet of streambank, create an 80-foot wide riparian buffer, and restore wetlands by removing artificial wetland drainage. Community outreach and environmental education will accompany project implementation. Shippensburg University students and faculty in the Geoenvironmental Studies Program will monitor and oversee the project.
- $141,646 (FY2000) to the Conodoguinet Creek Watershed Association to assess the impacts of removal of Good Hope Dam, which will reopen over thirty miles of the Conodoguinet Creek to migratory shad and herring. Streambanks will be restored and public outreach activities will be developed. The dam was removed through the PA Fish and Boat Commission's shad restoration program.
- $25,000 (FY2000) to the Franklin County Conservation District to install a water quality monitoring station on the Conodoguinet Creek near the Franklin/Cumberland County line, in cooperation with the U.S. Geological Survey (USGS), to gather baseline water quality data and to evaluate effects of future measures to correct excess nutrients and sediment.
- $4,495 (FY2000) to Cumberland Valley School District to reestablish a 2000-square foot autumnal/vernal pond that was drained in 1974 after nearby pipeline construction. The process will be videotaped and incorporated into a presentation for other educational institutions on how to restore these valuable wildlife habitats.
- $10,000 (FY1999) to the Franklin County Conservation District to construct cattle crossings and streambank fences on farms on the main branch of Muddy Creek, which will restore and protect about 2 miles of stream.
- $102,000 (FY1999) to Cumberland Valley Trout Unlimited to develop a model restoration project to demonstrate the effectiveness of new and innovative fluvial geomorphological (FGM) methods for streambank restoration and stabilization of lower Letort Spring Run.
- $140,000 (FY1999) to the Alliance for Aquatic Resource Monitoring (ALLARM) of Dickinson College to install stormwater management BMPs to improve waters quality and habitat and reduce siltation on the Letort Spring. BMPs include constructing a wetland and retention pond, a meadow, and stabilizing streambanks in Letort Park in the Borough of Carlisle.

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

- $40,112 (FY2002) to Cumberland County Conservation District to implement agricultural best management practices (BMPs) on farms in the Bulls Head Branch watershed.
- $387,525 (FY2001) (BMPs) on selected farms within impaired reaches of Conodoguinet Creek tributaries to reduce the amount of nutrients and sediment entering Conodoguinet Creek. BMPs include manure storages, roof runoff, field conservation practices and stream bank protection.
- $205,000 (FY2001) to Franklin County Conservation District to implement best management practices (BMPs) on selected farms within impaired reaches of Conodoguinet Creek tributaries to reduce the amount of nutrients and sediment entering Conodoguinet Creek. BMPs will include manure storage structures, barnyard runoff control, sediment basins, filter areas, and nutrient management assistance.
- $72,208 (FY1999) to the Susquehanna River Basin Commission (SRBC) for the Mount Rock Spring Creek project, an agricultural remediation project to reduce nutrients/sediments to a limestone spring

tributary. The stream was restored to its original channel using FGM methods. Stream fencing will be installed to exclude cattle from access to the creek. The Conodoguinet Creek Watershed Association, a partner in the project, is monitoring the success of the project.

- $22,450 (FY1999) to ALLARM for urban stormwater controls and restoration of the Mully Grub, a small tributary of the Letort Spring Run in Carlisle Borough.
- $131,000 (FY1990) to the USGS for the Pesticide Contamination and Land Use project, which was designed to look at the prevalence of various pesticides and the relationship to different land uses in the northern Cumberland Valley.

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

- $25,000 (FY1997) to the Conodoguinet Creek Watershed Association to develop a rivers conservation plan for the middle Conodoguinet Creek.
- $20,000 (1997) to the Letort Regional Authority to develop a rivers conservation plan for the Letort Spring Run watershed.

Chesapeake Bay Small Watershed Grants Program:

- $9,420 to the Central Pennsylvania Conservancy to create a riparian buffer and nature trail on 10 acres adjacent to a new development in Trindle Spring Run watershed as a model project for demonstrating the benefits of clustered development and stream protection.

Orphan Dam Removal:

- The deteriorating Good Hope Dam on the lower Conodoguinet Creek was removed in fall 2001 with funding through the PA Fish and Boat Commission (PFBC) shad restoration program. No current owner could be located to make the necessary repairs and install a fish ladder for shad migration.

**Public 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. This WRAS will be posted in the watershed notebook to allow for public comment and update. 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.

Citizen/Conservation Groups:

- The Conodoguinet Creek Watershed Association is dedicated to the restoration and protection of the Conodoguinet Creek watershed. The association sponsors citizen volunteer monitoring and presents programs for the public on pertinent issues and attributes of the creek. The association has been monitoring Mount Rock Spring as a partner in the EPA 319 Program stream restoration project and will take an active role in the Good Hope Dam removal project.
- The Letort Regional Authority is a watershed planning organization, active in restoration and protection of Letort Spring Run.
- Cumberland Valley Chapter Trout Unlimited conducts environmental education activities and stream improvement projects on area streams.
- Dickinson College Alliance for Aquatic Resource Monitoring (ALLARM) is active with citizen monitoring programs and watershed improvement projects.
- Cumberland County Conservation District provides expertise on conservation programs and technical assistance to county residents.
- Appalachian Trail Conference Mid Atlantic headquarter*s* works with volunteers to do education and improvement projects on trails.

- The Big Spring Watershed Association was formed in 2000 to lead the restoration of the habitat of Big Spring Creek.

**Funding Needs**
The total needed dollars for addressing all nonpoint source problems in the watershed is undetermined at this time and will be so until necessary TMDL's are developed for the watershed; however, existing programs that address nonpoint source issues in the watershed will continue to move forward. The TMDL for the Conodoguinet Creek tributaries with nonpoint pollution sources was drafted and put out for public comment in December 2000. TMDL's for Big Spring Creek and the main stem of Conodoguinet Creek were not included in this study. The Big Spring Creek watershed contains a fish hatchery that is a contributor of nutrients and oxygen demanding substances to the stream. The impairments in Big Spring Creek will first be addressed through changes to the fish hatchery's NPDES permit. The TMDL's for Bulls Head Branch and Green Spring Creek pesticide listing and Trindle Spring Run priority organics listing were deferred until quantitative evidence of the presence of specific chemicals in the streams is available.

Pennsylvania has developed a Unified Watershed Assessment to identify priority watersheds needing restoration. Pennsylvania has worked cooperatively with agencies, organizations and the public to define watershed restoration priorities. The Commonwealth initiated a public participation process for the unified assessment and procedures for setting watershed priorities. Pennsylvania's assessment process was published in the *Pennsylvania Bulletin, DEP Update* publication and World Wide Web site. It was sent to the Department's list of watershed groups, monitoring groups, and Nonpoint Source Program mailing list. Department staff engaged in a significant outreach effort which included 23 additional events to solicit public comment. The Department received 23 written comments from a variety of agencies, conservation districts and watershed groups. Pennsylvania is committed to expanding and improving this process in the future. After development of the initial WRAS a public participation process will take place to incorporate public input into expanding and "fine tuning" the WRAS for direction on use of 319 grant funds beyond FY2000.

**Total Maximum Daily Loads (TMDL's)**
TMDL's identify the amount of a pollutant that a stream or lake can assimilate without violating its water quality standards. TMDL's are calculated to include a margin of safety to protect against a mathematical or data error. TMDL's are set for each pollutant causing impairment.

<u>Summary of TMDLs for Conodoguinet Creek Tributaries</u>:
Total Maximum Daily Loads (TMDL's) were developed for 16 named tributary watersheds and 2 unnamed tributary watersheds in the Conodoguinet Creek subbasin to address impairments noted on Pennsylvania's 1996 and 1998 Clean Water Act Section 303d lists. The TMDL for the main stem of Conodoguinet Creek will be developed at a later date, after further analysis of the point source contributions to the stream. TMDL's were not developed for Big Spring Creek were not because the watershed contains the PA Fish Commission Big Spring Hatchery that is a contributor of nutrients and oxygen demanding substances to the stream. The impairments in Big Spring Creek will first be addressed through changes to the fish hatchery's NPDES permit.

A total of 50.1 miles of subbasin streams, including 28.8 miles of the main stem, were included on the 1996 303d list. The total length of impaired stream segments reached 206.97 miles on the 1998 303d list, including 84.2 miles of the main stem Conodoguinet Creek. The segments were listed based on physical habitat evaluations and biological surveys of the aquatic life in the streams and through the evaluation under the Department's Unassessed Waters Program. Excess nutrient and sediment loads from agriculture, construction, and urban runoff/ storm sewers were determined to be the causes of impairments.

The Conodoguinet Creek watershed has protected water uses for water supply, recreation and aquatic life. The aquatic life uses for the main stem of Conodoguinet Creek are cold water fishes in the upper watershed in Franklin County and warm water fishes in the rest of the creek. Many of the tributaries in the Conodoguinet Creek watershed are specially designated for warm water fishes, cold water fishes, trout stocking, high-quality waters, and exceptional value waters. Listed impairments indicate non-attainment of designated uses.

Agriculture is the primary land use (61.3%) in the Conodoguinet Creek watershed. Nearly 200,000 acres are in either cropland or hay/pasture. Cropland accounts for 38.6% of land use and pasture 22.7%. Agricultural land was identified as a major source of nutrients and sediment to the Conodoguinet Creek subbasin. Agricultural runoff from cropland and pasture can often contribute increased pollutant loads to a waterbody when poor farm management practices allow soils rich in nutrients from fertilizers or animal waste to be washed into the stream, increasing instream nutrient and sediment levels. Cattle and other agricultural animals deposit manure (nutrients) on the land surface, where it is available for runoff and delivery to receiving streams. Spreading animal manure on agricultural lands also contributes to nutrient washoff. The main stem Conodoguinet Creek is subject to significant sediment runoff; the creek flows very muddy after each moderate to heavy rainfall.

In stream systems, elevated nutrient loads (nitrogen and phosphorus) can lead to increased productivity of plants and other organisms. Aquatic plants use oxygen at night and animals that live in the stream use oxygen during the day. Excessive nutrient input can lead to elevated levels of productivity, which can subsequently lead to depressed dissolved oxygen levels when an abundance of aquatic life is drawing on a limited oxygen supply. Additional problems arise when these organisms die because the microbes that decompose this organic matter also consume large amounts of oxygen. A second effect of nitrogen (specifically ammonia) occurs when bacteria convert ammonia-nitrogen to nitrate-nitrogen. This process, called nitrification, also results in lower dissolved oxygen levels in streams.

On-site septic systems have the potential to deliver nutrients to surface waters due to system failure and malfunction. An estimated 7.1 percent of the Conodoguinet Creek watershed population uses septic systems. Normal septic systems contribute both dissolved nitrogen and phosphorus to the groundwater. Failed septic systems contribute greater amounts of nutrients to both groundwater and surface runoff.

Agriculture and septic systems are two major sources that enrich the groundwater. Based on water quality data from USGS, the estimated concentrations of nitrogen and phosphorus in groundwater in the Conodoguinet Creek agricultural areas were 2.7 mg/l and 0.019 mg/l, respectively, which are higher than the concentrations in the forested area (0.19 mg/l for nitrogen and 0.006 mg/l for phosphorus).

Along with population growth, increasing waste loads are creating an abundance of nutrients such as nitrogen and phosphorus. A total of 36-point source facilities are located in the Conodoguinet Creek basin. Only eight of these facilities, however, contribute significant amounts of nitrogen and/or phosphorus to the watershed. The Table below lists the eight discharging facilities identified as major point sources in the watershed and considered in the TMDL analysis.

**Major Point Source Facilities in the Conodoguinet Creek Subbasin**

| NPDES | Name | Property | Address | County | Receiving Waterbody |
|---|---|---|---|---|---|
| PA0038415 | East Pennsboro Township South Treatment | Sewerage Treatment | 98 South Enola Dr. | Cumberland | Conodoguinet Creek |
| PA0026077 | Carlisle STP | Sewerage Treatment | 53 West South St, Carlisle | Cumberland | Conodoguinet Creek |
| PA0028746 | Hampden Township STP | Sewerage Treatment | Pinebrook STP, Lamp Post Lane, Camp Hill | Cumberland | Conodoguinet Creek |
| PA0080314 | Hampden Township S.A. (Roth) STP | Sewerage Treatment | Roth Lane STP, 4200 Roth Lane, Mechanicsburg | Cumberland | Conodoguinet Creek |
| PA0020885 | Mechanicsburg Borough Municipal STP | Sewerage Treatment | 2 West Strawberry St, Mechanicsburg | Cumberland | Conodoguinet Creek |
| PA009865 | Pennsylvania Fish and Boat Commission, fish hatchery | Fish Hatcheries and Preserves | 844 Big Spring Road, Newville | Cumberland | Big Spring Creek |
| PA0030643 | Shippensburg Borough Authority | Sewage Treatment | 60 West Burd St, Shippensburg | Franklin | Middle Spring Creek |
| PA0010502 | Letterkenny Army Depot/IW | General Government | Franklin Street Extended, Chambersburg | Franklin | Rowe Run |

The Shippensburg Borough Authority sewerage treatment facility is identified as a significant contributor of nutrients to Middle Spring Creek, but it was not included in the TMDL analysis for Middle Spring Creek because Middle Spring Creek was listed only for sediment, not nutrient enrichment. The Shippensburg Borough Authority sewerage facility will, however, be included in the calculations for the total load reduction analysis developed for the entire Conodoguinet Creek basin. All of the potential sources mentioned above were considered in the watershed modeling for this TMDL.

Nutrients and sediment are the most likely pollutants causing the impairments identified in the listed segments of the Conodoguinet Creek basin. This conclusion is based on the dominant source types, the observed high sediment and nutrient loading, observations of the biological assessment teams, and similarities to other impaired waterbodies.

The biological assessment in the Conodoguinet Creek basin listed organic enrichment/low dissolved oxygen (DO) as the cause of the impairment seen in some portions of the subbasin streams. This listing was based on visual observation; no dissolved oxygen readings were used as the basis for this impairment listing. Impairment caused by organic enrichment/low DO is addressed through reduction to the phosphorus loading.

Typically in aquatic ecosystems the quantities of trace elements are plentiful; however, nitrogen and phosphorus may be in short supply. The nutrient that is in the shortest supply is called the limiting nutrient because its relative quantity affects the rate of production (growth) of aquatic biomass. If the nutrient load to a waterbody can be reduced, the available pool of nutrients that can be utilized by plants and other organisms will be reduced and, in general, the total biomass can subsequently be decreased as well. In most efforts to control eutrophication processes in waterbodies, emphasis is placed on the limiting nutrient. This is not always the case, however. For example, if nitrogen is the limiting nutrient, it still might be more efficient to control phosphorus loads if the nitrogen originates from sources that are difficult to control, such as nitrates in groundwater.

In most freshwater bodies, phosphorus is the limiting nutrient for aquatic growth. In some cases, however, the determination of which nutrient is the most limiting is difficult. For this reason, the ratio of the amount of nitrogen to the amount of phosphorus is often used to make this determination. If the nitrogen/phosphorus ratio is less than 10, nitrogen is limiting; if the nitrogen/phosphorus ratio is greater than 10, phosphorus is the limiting nutrient. In the case of listed stream segments (nutrients and organic enrichment) in the Conodoguinet Creek basin, the nitrogen/phosphorus ratios are all greater than 15, pointing to phosphorus as the limiting nutrient. The nutrient portions of the TMDL's for the impaired watersheds, therefore, address only phosphorus because it was determined that phosphorus was the limiting nutrient for plant growth in all the streams listed for nutrient or organic enrichment in the Conodoguinet Creek basin. Controlling the phosphorus loading to listed stream segments in the Conodoguinet Creek basin will limit plant growth and reduce eutrophication.

**Nitrogen/Phosphorus Ratios in Streams Listed for Nutrients and/or Organic Enrichment in the Conodoguinet Creek Subbasin**

| Streams | Listed Causes | Nitrogen/Phosphorus ratio |
|---|---|---|
| Big Spring Creek | Organic enrichment and siltation | 16 |
| Bulls Head Branch and Green Spring Creek | Siltation, nutrients, and organic enrichment | 25 |
| Center Run and Back Run | Siltation and organic enrichment | 28 |
| Clippingers Run | Nutrients and organic enrichment | 28 |
| Hogestown Run | Organic enrichment | 24 |
| Mount Rock Spring Creek | Nutrients and siltation | 20 |
| Newburg Run | Nutrients and siltation | 30 |
| Rowe Run | Organic enrichment and siltation | 21 |

Pennsylvania has no numeric in-stream criteria for the pollutants of concern; therefore, a reference watershed approach was developed to identify the TMDL endpoints or water quality objectives for phosphorus and sediment in the impaired segments of the Conodoguinet Creek basin. The reference watershed approach pairs two watersheds, one attaining its uses and one that is impaired based on biological assessment. Two factors form the basis for selecting a suitable reference watershed. The first factor is to use a watershed that was assessed by the PADEP using the Unassessed Waters Protocol and determined to attain water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, ecoregion, size, and geology. Both watersheds must have similar land cover and land use characteristics. Other features such as base geologic formation should be matched to the extent possible; however, most variations can be adjusted in the watershed model.

Once the reference watersheds are selected, their existing loading values are estimated based on watershed modeling using state GIS data. The estimated existing loading values are analyzed and considered as the endpoints or target limits. The current loading rates for the pollutants of interest from a selected unimpaired watershed are determined and compared to the impaired watersheds estimates. The objective of the process is to reduce the loading rate of nutrients and sediment in the impaired stream segment to a level equivalent to or slightly lower than the loading rate in the unimpaired reference stream segment. Achieving the phosphorus and/or sediment loadings recommended in the TMDL's will ensure that the aquatic life use of the impaired stream is achieved.

The TMDL endpoints established for this study were determined using Lehman Run, Peebles-Bear Hollow Run, Griers Hollow-Devil Alex Hollow-Mountain Run, Upper Letort Spring Run, and Upper Yellow Breeches as the reference watersheds. The Table below presents the listed watersheds and their corresponding reference watersheds and endpoints.

**Summary of Reference Watersheds and TMDL Endpoints**

| Reference (Unimpaired) Watershed | Impaired Watershed | Existing Loads | | TMDL Endpoint | |
|---|---|---|---|---|---|
| | | Phosphorus (lb/ac/yr) | Sediment (lb/ac/yr) | Phosphorus (lb/ac/yr) | Sediment (lb/ac/yr) |
| Lehman Run | Newburg Run | 0.42 | 304.27 | 0.36 | 240.25 |
| | Clippingers Run | 0.49 | 407.17 | | |
| | UNT 7403 | 0.49 | 421.95 | | |
| Peebles/Bear Hollow Run | Center Creek and Back Creek | 0.43 | 327.60 | 0.35 | 253.27 |
| | Paxton Run | 0.46 | 333.77 | | |
| | Wertz Run | 0.42 | 397.94 | | |
| | UNT1605 | 0.68 | 601.99 | | |
| Griers Hollow/Devil/Alex Hollow/Mountain Run | Mains Run and Gum Run | 0.39 | 456.70 | 0.31 | 366.60 |
| Yellow Breeches Creek-5K | Alexanders Spring Creek | 0.89 | 694.20 | 0.63 | 483.20 |
| | Bulls Head Branch and Green Spring Creek | 0.80 | 543.64 | | |
| | Hogestown Run | 0.88 | 609.00 | | |
| | Mount Rock Spring Creek | 0.93 | 704.40 | | |
| | Rowe Run | 1.03 | 690.04 | | |
| Yellow Breeches Creek-2K[c] | Middle Spring Creek | 1.29 | 546.79 | 0.61 | 497.08 |
| (Upper) Letort Spring Run | Trindle Spring Run | 0.76 | 521.09 | 0.66 | 475.68 |

The TMDL was developed using the Generalized Watershed Loading Function (GWLF) model which provides the ability to simulate runoff, sediment, and nutrient (N and P) loadings from a watershed with variable size source loads, e.g., agricultural, forested, and developed land. Septic loads may also be calculated and point sources may be included where applicable. Adjustments were made to the model to compensate for the differences between the impaired and reference watershed. Load allocations were made for the sources of P and sediment from hay/pasture, row crops, coniferous, mixed forest, deciduous, low and high intensity development, quarries, groundwater, and septic systems.

The TMDL's for each impaired watershed consist of a nonpoint source load allocation (LA), a point source wasteload allocation (WLA), and a margin of safety (MOS) for the pollutants.

The load reduction in the impaired watersheds was based on current loading rates for phosphorus and/or sediment in the reference watersheds. The pollutant loading rates were computed for the reference watersheds using the GWLF model. These loading rates were then used as the basis for establishing the TMDL's for the impaired watersheds. The TMDL equation is TMDL=WLA + LA + MOS.

**TMDL's for Subwatersheds in the Conodoguinet Creek Watershed**

| Listed Stream | Pollutant | TMDL (lb/yr) | Load Allocation (LA) (lb/yr) | Waste Load Alloca -tion (WLA) (lb/yr) | MOS (lb/yr) | Existing Load (lb/yr) | Load Reduction (lb/yr) | % Reduc-tion |
|---|---|---|---|---|---|---|---|---|
| Alexanders Spring Creek | Sediment | 5,904,194 | 5,313,774 | 0 | 590,419 | 8,482,433 | 3,168,659 | 37% |
| Bulls Head Branch & Green Spring Creek* | Phosphorus | 10,853 | 9,768 | 0 | 1,085 | 13,754 | 3,986 | 29% |
| | Sediment | 8,279,005 | 7,451,105 | 0 | 827,901 | 9,314,545 | 1,863,440 | 20% |
| Center Creek & Back Creek* | Phosphorus | 1,456 | 1,310 | 0 | 146 | 1,815 | 505 | 28% |
| | Sediment | 1,059,531 | 953,578 | 0 | 105,953 | 1,370,464 | 416,886 | 30% |
| Clippingers Run | Phosphorus | 1,026 | 923 | 0 | 103 | 1,395 | 472 | 34% |
| Hogestown Run | Phosphorus | 7,133 | 6,419 | 0 | 713 | 9,855 | 3,436 | 35% |
| | Sediment | 5,440,933 | 4,896,839 | 0 | 544,093 | 6,857,481 | 1,960,642 | 29% |
| Mains Run & Gum Run* | Sediment | 1,705,742 | 1,535,168 | 0 | 170,574 | 2,124,970 | 589,802 | 28% |
| Middle Spring Creek | Sediment | 2,532,681 | 2,279,413 | 0 | 253268 | 2,785,986 | 506,573 | 18% |
| Mount Rock Spring Creek | Phosphorus | 9,953 | 8,958 | 0 | 995 | 14,673 | 5,715 | 39% |
| | Sediment | 7,592,471 | 6,833,224 | 0 | 759,247 | 11,068,148 | 4,234,924 | 38% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Newburg Run | Phosphorus | 1,315 | 1,183 | 0 | 131 | 1,523 | 340 | 22% |
| | Sediment | 873,236 | 785,913 | 0 | 87,324 | 1,105,941 | 320,028 | 29% |
| Paxton Run | Sediment | 1,179,690 | 1,061,721 | 0 | 117,969 | 1,554,607 | 492,886 | 32% |
| Rowe Run | Phosphorus | 7,604 | 5,078 | 1,765 | 760 | 12,376 | 5,533 | 45% |
| | Sediment | 5,800,318 | 5,220,286 | 0 | 580,032 | 8,283,209 | 3,062,923 | 37% |
| Trindle Spring Run | Sediment | 5,377,457 | 4,839,711 | 0 | 537,746 | 5,890,754 | 1,051,043 | 18% |
| Wertz Run | Sediment | 914,964 | 823,468 | 0 | 91,496 | 1,437,577 | 614,109 | 43% |
| Unnamed 970729-1605-JLR | Sediment | 1,157,160 | 1,041,444 | 0 | 115,716 | 2,750,374 | 1,708,929 | 62% |
| Unnamed 7403 | Sediment | 655,966 | 590,369 | 0 | 65,597 | 1,152,104 | 561,735 | 49% |
| **Total Phosphorus** | | | | | | **55,391** | **19,987** | **36%** |
| **Total Sediment** | | | | | | **64,178,593** | **20,552,580** | **32%** |

* Aggregated watershed

| **Land Use Types in the Conodoguinet Creek Watershed Used in the TMDL Calculations** | | |
|---|---|---|
| **Land Use Types** | **Area (acres)** | **% Total** |
| Water Bodies | 2,606.6 | 0.8% |
| Low Intensity Development | 11,331.0 | 3.5% |
| High Intensity Development | 4,854.8 | 1.5% |
| Hay/Pasture | 73,749.2 | 22.7% |
| Cropland | 125,148.4 | 38.6% |
| Forest | 4,816.3 | 1.5% |
| Mixed Forest | 7,046.7 | 2.2% |
| Deciduous Forest | 92,244.5 | 28.4% |
| Woody Wetland | 1,507.8 | 0.5% |
| Emergent Wetland | 643.2 | 0.2% |
| Quarry | 74.2 | 0.0% |
| Transitional Land * | 343.8 | 0.1% |
| **Total** | 324,366.5 | 100% |

*=Land under construction

Urban areas are represented in the land use coverage by the high-intensity developed and low-intensity developed land uses. Nutrients from nonpoint sources are carried into streams through surface runoff and through erosion from unpaved areas and construction sites. Sources of sediment mainly include unpaved areas and construction sites. Some construction sites are represented by the transitional (barren) land in the land use coverage.

| Required Load Reductions for Subwatersheds of Conodoguinet Creek | | | | | |
|---|---|---|---|---|---|
| **Impaired Stream** | **Impairment Type** | **Average Annual Load (lb/yr)** | **Load Allocation (lb/yr)** | **Land Use Category** | **Load Reduction Needed %** |
| Alexanders Spring Creek | Sediment | 8,482,433 | 5,313,774 | Hay/Pasture<br>Cropland | 7.8<br>39.1 |
| Bulls Head Branch/ Green Spring Creek | Phosphorus | 13,739 | 9,768 | Hay/Pasture<br>Cropland<br>Quarry | 12.0<br>35.2<br>12.0 |
| | Sediment | 9,314,545 | 7,451,105 | Hay/Pasture<br>Cropland<br>Quarry | 6.9<br>20.9<br>6.9 |
| Center/Back Creek | Phosphorus | 1,815 | 1,310 | Hay/Pasture<br>Cropland | 22.1<br>37.5 |
| | Sediment | 1,370,464 | 953,578 | Hay/Pasture<br>Cropland | 15.7<br>35.9 |
| Clippingers Run | Phosphorus | 1,395 | 923 | Hay/Pasture<br>Cropland<br>Transition | 23.0<br>47.5<br>23.0 |
| Hogestown Run | Phosphorus | 9,855 | 6,419 | Hay/Pasture<br>Cropland | 14.0<br>43.7 |
| | Sediment | 6,857,481 | 4,896,839 | Hay/Pasture<br>Cropland | 8.7<br>30.1 |
| Mains Run/ Gum Run | Sediment | 2,124,970 | 1,535,168 | Hay/Pasture<br>Cropland<br>Transition | 29.4<br>31.1<br>29.4 |
| Middle Spring Creek | Sediment | 2,785,986 | 2,279,413 | Hay/Pasture<br>Cropland<br>Low Inst Dev<br>High Inst Dev | 9.1<br>19.0<br>9.1<br>9.1 |
| Mount Rock Spring Creek | Phosphorus | 14,673 | 8,958 | Hay/Pasture<br>Cropland | 11.9<br>45.9 |
| | Sediment | 11,068,148 | 6,833,224 | Hay/Pasture<br>Cropland<br>Low Inst Dev<br>High Inst Dev | 8.0<br>40.0<br>8.0<br>8.0 |
| Newburg Run | Phosphorus | 1,523 | 1,183 | Hay/Pasture<br>Cropland | 21.0<br>30.5 |
| | Sediment | 1,105,941 | 785,913 | Hay/Pasture<br>Cropland | 15.4<br>34.3 |
| Paxton Run | Sediment | 1,554,607 | 1,061,721 | Phosphorus | 909<br>35.6 |

| Required Load Reductions for Subwatersheds of Conodoguinet Creek | | | | | |
|---|---|---|---|---|---|
| **Impaired Stream** | **Impairment Type** | **Average Annual Load (lb/yr)** | **Load Allocation (lb/yr)** | **Land Use Category** | **Load Reduction Needed %** |
| Rowe Run | Phosphorus | 12,376 | 6,843 | Hay/Pasture<br>Cropland<br>Transition | 21.5<br>65.4<br>21.5 |
| | Sediment | 8,283,209 | 5,220,286 | Hay/Pasture<br>Cropland<br>Transition | 10.7<br>39.2<br>10.7 |
| Trindle Spring Run | Sediment | 5,890,754 | 4,839,711 | Hay/Pasture<br>Cropland<br>Quarry<br>Low Inst Dev<br>High Inst Dev | 10.1<br>18.7<br>10.1<br>10.1<br>10.1 |
| Wertz Run | Sediment | 1,437,577 | 823,468 | Hay/Pasture<br>Cropland<br>Low Inst Dev<br>High Inst Dev | 13.6<br>61.1<br>13.6<br>13.6 |
| Unnamed Tributary 1605 | Sediment | 2,750,374 | 1,041,444 | Hay/Pasture<br>Cropland | 18.6<br>74.5 |
| Unnamed Tributary 7043 | Sediment | 1,152,104 | 590,369 | Hay/Pasture<br>Cropland | 23.1<br>63.3 |

Implementation of the proposed TMDL's for tributary watersheds will reduce phosphorus and sediment loads to the main stem by 9.8 percent and 11.3 percent, respectively. These TMDL's do not directly address habitat modification, which is not a pollutant; however, reductions of sediment and nutrient loads should also benefit habitat conditions. Management practices expected to be used in reducing sediment and nutrient loads will include riparian zone management that benefits habitat conditions as well, through stream shading and stream bank protection.

The majority of the sediment and phosphorus reductions in the TMDL's are allocated to agricultural activities in the watershed. Implementation of best management practices (BMPs) in the affected subwatersheds should achieve the loading reduction goals established in the TMDL's. Substantial reductions in the amount of sediment reaching the streams can be made through the planting of riparian buffer zones, contour strips, and cover crops. These BMPs range in efficiency from 20% to 70% for sediment reduction. Implementation of BMPs aimed at sediment reduction will also assist in the reduction of phosphorus. Additional phosphorus reductions can be achieved through the installation of more effective animal waste management systems and stone ford cattle crossings. Other possibilities for attaining the desired reductions in phosphorus and sediment include stabilization of streambanks and streambank fencing. Further field evaluations will be performed in order to assess both the extent of existing BMPs, and to determine the most cost-effective and environmentally protective combination of BMPs required for meeting the sediment and nutrient reductions.

Additional information and loadings calculations can be found in the Draft TMDL on the Department's website at http://www.dep.state.pa.us/, choose directLINK, TMDL, Conodoguinet Creek.

**Restoration Needs:**
Restoration activities should be concentrated on impaired stream segments and those for which TMDL's have been developed. The majority of the impairments in the Conodoguinet Creek watershed are nutrient enrichment and low dissolved oxygen (DO) and sedimentation from agricultural runoff.

Implementation of agricultural BMPs in the affected areas should reduce nutrient and sediment loads. Installation of BMPs has begun in several of these watersheds. Streambank stabilization and fencing will reduce phosphorus and sediment loads. Stabilizing streambanks will also help reduce instream erosion. Fencing will keep livestock out of the stream and provide a riparian zone along the stream to trap sediment and phosphorus, thus keeping these pollutants from reaching the stream. Contour farming and grass waterways will help reduce sediment runoff during storms. Manure management practices should be implemented on farms to control runoff of manure from animal feeding and milking areas.

Significant trends in reductions in nutrients and suspended solids residue have been documented after installation of agricultural BMPs. The strongest trends were a greater than 50% reduction in concentrations of total and dissolved phosphorus (P) and suspended solids in base flow in Mill Creek and Muddy Run in Lancaster County. Storm flow samples showed a 31% reduction in total P concentrations in Mill Creek and a 54% decrease in nonfilterable residue in Muddy Run; however, a trend of 54% increase in total ammonia nitrogen was noted in Muddy Run during storm flow.

A USGS study indicated that streambank fencing in connection with other BMPs such as stream crossings, manure storage, and rotational grazing is effective in reducing polluted runoff and improving water quality during both base flow and storm flow events. More agricultural BMPs are necessary to complete the restoration efforts already begun.

**References/Sources of information:**

- State Water Plan, Subbasin 7, Lower Susquehanna River. Department of Environmental Protection, February 1980
- USGS Topographic Maps319 project proposals and summaries
- DEP: Watershed Notebooks, Unified Assessment Document, and information from files and databases.
- 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
- Groundwater and the Geology of the Cumberland Valley, Cumberland County, PA Water Resource Report 50, PA Topographic and Geological Survey, 1981.
- Draft TMDL's for Conodoguinet Creek Watershed. DEP Bureau of Watershed Conservation. December 2000.

**Streams in Subbasin 07B: 303d/305b Listings**

| Stream | Stream Code | Drainage area square miles | Miles Attained | Miles Impaired | Causes/Sources/ *Comments/Chapter 93 Special Protection* |
|---|---|---|---|---|---|
| **2-Conodoguinet Creek** | 10194 | 506 | 105 main stem; & 467.02, 101 UNTs | 11 UNTs | Nutrients, suspended solids, organic enrichment/low DO from AG or unknown habitat alterations *HQ-CWF upper basin* |
| 3-Bear Valley Run & one UNT | 10847 | 3.03 | 4.67 | | *HQ-CWF; Class A brook trout* |
| 3-Dothan Run | 10839 | 1.16 | 2.91 | | *HQ-CWF* |
| 3-Pine Run near Roxbury & 4 UNTs | 10821 | 3.59 | 6.75 | | *HQ-CWF* |
| 3-Trout Run & 2 UNTs | 10815 | 8.33 | 9.2 | | *EV, upper basin* |
| **3-Muddy Run** & 44 UNTs | 10662 | 42.1 | 41.17 | | |
| 4-Lehman Run & 17 UNTs | 10700 | 3.03 | 17.24 | | |
| 5-Keasey Run & 24 UNTs | 10708 | 11.2 | 24.45 | | |
| 3-Rowe Run & 15 UNTs | 10668 | 18.0 | | 19.75 | Organic enrichment/low DO and siltation from AG |
| **3-Middle Spring Creek** | 10602 | 47.7 | 1.44 main stem; 7.19, 9 UNTs | 5.97 main stem | Suspended solids from AG and urban runoff/storm sewers; *Limestone spring* |
| 4-Furnace Run & 6 UNTs | 10630 | 11.0 | 10.38 | | |
| 5-Shirley Run & one UNT | 10633 | 1.28 | 3.38 | | |
| 4-Gum Run & 2 UNTs | 10624 | 7.10 | | 7.79 | Siltation, habitat alterations from AG and Habitat modification |
| 5-Mains Run & 2 UNTs | 10625 | 2.31 | | 5.96 | Siltation and habitat alteration from AG and Habitat modification |
| 4-Burd Run | 10611 | 20.5 | 4.84 | | |
| 5-Thompson Creek | 10616 | 8.64 | 2.24 | | |
| 5-"Reservoir Hollow" & one UNT | 10613 | 5.83 | 8.6 | | |
| 3-Paxton Run & 10 UNTs | 10549 | 17.3 | | 9.03 | Suspended solids and siltation from AG |

| Stream | Stream Code | Drainage area square miles | Miles Attained | Miles Impaired | Causes/Sources/ *Comments/Chapter 93 Special Protection* |
|---|---|---|---|---|---|
| 4-Clippingers Run | 10568 | 4.40 | 3.0 main stem; 9.95, 10 UNTs | 0.83 main stem | Organic enrichment/low DO, nutrients from AG |
| 4-Laughlin Run & 13 UNTs | 10551 | 5.54 | 17.2 | | |
| 3-Newburg Run | 10531 | 5.48 | 3.38 main stem; 7.90, 8 UNTs | 2.16 main stem | Nutrients and siltation from AG |
| 3-Peebles Run & 10 UNTs | 10496 | 7.24 | 14.58 | | |
| 4-"Bear Hollow" & 3 UNTs | 10504 | 1.26 | 6.10 | | |
| 4-Koser Run & 2 UNTs | 10497 | 0.76 | 2.21 | | |
| 3-Three Square Hollow Run & 14 UNTs | 10459 | 12.6 | 22.8 | | |
| 4-Bore Mill Run & 9 UNTs | 10468 | 4.32 | 10.95 | | |
| 5-"Wasp Hollow" | 10477 | | 0.98 | | |
| 3-Brandy Run& 13 UNTs | 10444 | 5.84 | 14.16 | | |
| 3-Whisky Run & 2 UNTs | 10439 | 3.83 | | 5.03 | Unknown source and cause |
| 3-Green Spring Creek & 6 UNTs | 10430 | 25.8 | | 7.61 | Nutrients, siltation, organic enrichment/ low DO, pesticides from AG and other *Limestone spring* |
| 4-Bulls Head Branch & one UNT | 10431 | 23.0 | | 9.4 | Siltation, pesticides, organic enrichment/low DO from AG & Other *Limestone spring* |
| 3-Back Creek & one UNT | 10417 | 6.54 | | 4.34 | Siltation and organic enrichment/ low DO from AG |
| 4-Center Creek | 10419 | 2.47 | 1.48 main stem | 2.11 main stem; 1.48 one UNT | Siltation and organic enrichment/ low DO from AG |
| 3-Doubling Gap Creek & 31 UNTs | 10385 | 16.5 | 38.46 | | *HQ-CWF, upper basin* |

| Stream | Stream Code | Drainage area square miles | Miles Attained | Miles Impaired | Causes/Sources/ *Comments/Chapter 93 Special Protection* |
|---|---|---|---|---|---|
| 3-Big Spring Creek | 10378 | 12.9 | 1.46 main stem; 1.27, 2 UNTs | 3.5 main stem | Organic enrichment/low DO and siltation from Other sources *Limestone spring; EV, upper basin; Class A brook trout, upper 0.6 mile* |
| 3-Rock Run & 7 UNTs | 10367 | 3.35 | 8.55 | | |
| 3-Bloser Creek & 10 UNTs | 10343 | 5.59 | 16.7 | | |
| 3-Locust Creek& 17 UNTs | 10321 | 7.63 | 20.47 | | |
| 3-Mount Rock Spring Creek & one UNT | 10319 | 24.6 | | 8.66 | Nutrients and siltation from AG and Construction *Limestone spring* |
| 3-Opossum Creek & 13 UNTs | 10303 | 5.13 | 11.91 | | *HQ-CWF, upper basin* |
| 3-Alexanders Spring Creek | 10302 | 19.2 | | 3.81 | Siltation from AG & Construction *Limestone spring* |
| 3-Meetinghouse Run & one UNT | 10288 | 2.58 | 4.08 | | |
| 3-Wertz Run | 10276 | 5.71 | 2.17 main stem; 6.55, 8 UNTs | 1.74 main stem | Siltation from AG and Construction |
| 3-Spring Run & 5 UNTs | 10264 | 3.98 | 7.44 | | |
| 3-Letort Spring Run | 10261 | 21.7 | 8.25 main stem; 0.88, 2 UNTs | 1.0 main stem | Urban runoff/ storm sewers & Other habitat alterations *Limestone spring; HQ-CWF, upper basin, EV, middle basin; Class A* brown *trout, middle 3.6 miles* |
| 3-Simmons Creek & 10 UNTs | 10225 | 5.13 | 9.67 | | |
| 3-Hogestown Run & 2 UNTs | 10224 | 17.7 | | 10.37 | Organic enrichment/low DO, Unknown, siltation from AG, Urban runoff/storm sewers *Limestone spring* |
| 3-Trindle Spring Run & one UNT | 10222 | 19.6 | 2.3 | 7.97 | Priority organics, siltation, unknown from Land disposal, Construction, Urban runoff/storm sewers, AG; Fish consumption advisory for PCB upper reaches *Limestone spring; Class A rainbow trout, lower 0.9 mile* |
| 3-Sears Run | 10210 | 4.95 | 3.22, | 1.04 main | Siltation & unknown from |

| Stream | Stream Code | Drainage area square miles | Miles Attained | Miles Impaired | Causes/Sources/ *Comments/Chapter 93 Special Protection* |
|---|---|---|---|---|---|
| | | | 6 UNTs | stem | Construction, land disposal |
| 3-Holtz Run & 4 UNTs | 10200 | 3.60 | 4.06 | | |
| 4-Pine Run at Enola & one UNT | 10201 | 1.25 | 1.77 | | |

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. The Susquehanna River=1.

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

The subbasin was evaluated under the unassessed waters program by biologists with the Susquehanna River Basin Commission in 1997. Totals for impaired and attained include the main stem and unnamed tributaries where indicated.