Updated 4/2004

Watershed Restoration Action Strategy (WRAS)
State Water Plan Subbasin 07D
Swatara Creek Watershed
Dauphin, Lebanon, Berks, and Schuylkill Counties

Introduction

Subbasin 07D consists solely of the 571-square mile Swatara Creek watershed, part of the Susquehanna River basin. Major tributaries are the Little Swatara Creek at 99.2 square miles and the Quittapahilla Creek at 77.3 square miles. Five other tributaries have drainage areas over 20 square miles: Lower Little Swatara Creek at 35.6 square miles, Manada Creek at 32.2 square miles, Beaver Creek at 27.2 square miles, Upper Little Swatara Creek at 24.3 square miles, and Spring Creek at 24 square miles.

The Swatara Creek flows for 71 miles through four counties. Swatara Creek originates in southwestern Schuylkill County near the borough of Tremont, flows through the western edge of Berks County, Lebanon County, and southern Dauphin County to its confluence with the Susquehanna River at the borough of Middletown. The headwaters are at an elevation of 1,510 feet and the mouth at 279 feet. The subbasin includes 732 streams flowing for a total of 950 miles. The subbasin is included in HUC Area 2050305, Lower Susquehanna-Swatara Creek, a Category I, FY99/2000 Priority watershed in the Unified Watershed Assessment.

Geology/Soils:

Subbasin 07D lies within two Ecoregions, the Northern Ridge and Valley (67) and the Northern Piedmont (64). Most of the upper Dauphin County and Lebanon County portions of the subbasin is located within the Northern Ridge and Valleys Ecoregion, Northern Shale Valleys section (67b). The majority of the surface strata is comprised of shale and siltstone interbedded with limestone and dolomite of the Martinsburg Formation. The terrain in this section consists of rolling agricultural valleys and low hills, with some steeper ridges. Many small tributaries flow down the narrow valleys between the hills. The soil is shallow and very rocky. The shale absorbs less precipitation and the streams are larger and the runoff potential is greater than in the carbonate valley to the south. The strata in the upper Little Swatara Creek and the Fishing Creek watersheds are of the Devonian Age, Catskill Formation comprised of red to brown shale and sandstone and the Marine Beds comprised of gray to olive brown shale.

The crest of Blue Mountain that transects the subbasin is part of the Northern Ridge and Valleys Ecoregion ,Northern Sandstone Ridges section (67c) comprised of erosion-resistant quartzitic sandstone. This is an area of steep northeast-southwest trending ridges and forested slopes in which high gradient streams flow off the mountains through narrow valleys. These streams usually have low buffering capacity and are often acidic. The steep terrain and rocky soils limit agricultural development in this section of the subbasin.

A wide band of the Northern Ridge and Valleys Ecoregion, Northern Limestone/Dolomite Valleys section (67a) passes through the lower third of the subbasin, along US Route 422 in the Lebanon-Annville-Hershey area. This region, known as the Lebanon Valley, is a flat lying to gently sloping limestone valley with caves, solution cavities and sinkholes; much of the drainage is subsurface. Streams are generally small and shallow except where replenished by larger springs. The Quittaphilla Creek is the major waterway draining this area. This limestone band and the limestone mixed in the shale section result in neutral to alkaline waters and productive agricultural soils throughout much of the lower elevation portions of the subbasin. This limestone section, however, provides the most productive soils and is mainly in agricultural use for crops.

The upper main stem Swatara Creek watershed is within the Northern Ridge and Valleys Ecoregion, Anthracite section (67e) which contains strata of sandstone, shale, siltstone, conglomerate and mineable coals. Stream flow, surface runoff, and the landscape have been severely altered by the many surface and underground coal mining activities. Huge coal refuse piles (culm banks) and numerous abandoned, open surface mine pits cover esxtensive areas of this area. Twenty-five coal seams were present in this area of the subbasin. The strata are steeply tilted and mines penetrated deep into the hillsides. The folding and faulting increased the amount of coal available to mine. The rock units are inverted in some places and lie in bowl-like basins. In some basins, the coal is at depths of 6,000 feet. Tunnels bored between mountains allowed water exchange between watersheds within and outside the subbasin. The sulfur content of the coals ranged from 0.5 percent to 2.0 percent and averaged 0.7 percent.

The lower portion of the main stem downstream of Hummelstown and the upper end of the Quittapahilla Creek watershed near Cornwall are within the Northern Piedmont Ecoregion, Triassic Lowlands section (64a) comprised non-carbonate sedimentary rocks of red and brown sandstone, shale, siltstone, and conglomerate and low rolling terrain. The soils are less productive than those of the carbonate valley but still provide good soils for farming. These lowlands have intrusions of the igneous rock diabase, part of the Northern Piedmont Ecoregion, Diabase and Conglomerate Uplands section (64b), which have baked the adjacent sandstone into arkos sandstone and argillite, called Trap Rock. The topography of this portion of the subbasin is mainly comprised of low rolling hills interrupted by low diabase ridges and boulders.

<u>Land Use</u>:
Land use through the subbasin is diverse ranging from large tracts of deciduous forest to regional commercial centers and many villages and boroughs. Agriculture is the largest land use, totaling over 206,000 acres or 56.5% of the subbasin, the majority of which is located south of Blue Mountain. Nearly all the agriculture land is in cropland and pasture. Forested lands comprise 118,000 acres or 32.5% of the subbasin, most of which is located north of Blue Mountain. The most highly urbanized and commercial land is along the US Route 422 corridor which passes through the boroughs or villages of Lebanon, Cleona, Annville, Palmyra, Hershey, and Hummelstown. Major highways traversing the subbasin are I-76 (PA Turnpike), I-81 and I-78 and US Routes 422, 322, 22 and 209. A large U.S. government installation, Fort Indiantown Gap, is located in northern Lebanon County and is used for military training exercises. Large areas of barren land, abandoned surface mines and coal refuse piles are located in the northern main stem watershed in Schuylkill County.

The subbasin contains all or parts of 46 municipalities in four counties. All but 2 municipalities, both of which are in Schuylkill County, have zoning ordinances. Residential land use is expanding in the subbasin especially around the US 422 corridor and the eastern suburbs of the City of Harrisburg. The estimated population was 291,000 persons in 1998. The population increased by 3.2 percent from 1990 to 1998; this contrasts with the average Pennsylvania growth rate of one percent. The highest population increases were for townships surrounding the boroughs, indicating a population shift from urban to rural. Schuylkill County was the only county in the subbasin that decreased in population during this time period.

<u>Natural/Recreational Resources</u>:
<u>DEP Chapter 93 Exceptional Value (EV) and High-Quality (HQ) Stream Listings</u>:
<u>EV streams</u>:
- Mill Creek at Suedberg, source to City of Lebanon Authority Dam

<u>HQ Streams</u>:
- Monroe Creek, source to tail waters of Lake Strause

Fisheries:
Portions of the following streams are stocked with trout by the PA Fish and Boat Commission and open for public fishing:

- Mill Creek at Suedberg; also has some trout reproduction
- Little Swatara Creek
- Manada Creek, also has some trout reproduction
- Trout Run
- Quittapahilla Creek
- Bachman Run
- Snitz Creek
- Upper Little Swatara Creek
- Lower Little Swatara Creek

Other Recreational Resources:
Much of the forested areas in the mountains is in public ownership either as State Game Lands, State Forest lands or water supply watersheds for local municipalities. Memorial Lake State Park is located in the Lebanon County portion of the watershed. Swatara State Park is located between I-81 and PA Route 443 where Swatara Creek cuts through Blue Mountain. This park is largely undeveloped pending the decision as to whether a dam will be placed on the Swatara Creek. Studies by the U.S. Fish and Wildlife Service indicated that the dam would flood numerous significant wetlands. DCNR has withdrawn their permit application.

Water Quality Impairment
Three nonpoint pollution sources exist within the subbasin: abandoned mine drainage (AMD) from coal mining operations in the northern main stem watershed, nutrient enrichment from agricultural runoff primarily in the central subbasin, and urban runoff in the lower region. As expected, land use and geology correlate with the observed differences in water quality contamination of surface and groundwater. Agricultural areas underlain by limestone bedrock have higher concentrations of nitrates and pesticides than agricultural areas underlain by shale and sandstone.

Monitoring/Evaluation:
Ninety-eight percent of the subbasin was assessed under the Department's Unassessed Waters Program from 1996 through 1999. Results of the evaluation indicated that out of 905 total miles in the subbasin, 369 miles or 42% were impaired. Causes of impairment were:

1. Nutrients
2. Siltation
3. Organic enrichment/low dissolved oxygen (DO)
4. Flow alterations from agriculture, especially crop related agriculture
5. Excessive algal growth and nutrients from municipal point sources
6. Siltation and flow alterations from urban runoff and storm sewers
7. Siltation from road runoff
8. Low pH and siltation from abandoned mine drainage (AMD)

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.

Numerous studies have been conducted on the upper Swatara Creek watershed in conjunction with the plans for constructing a dam in Swatara State Park. The U.S. Geological Service (USGS) has also conducted extensive sampling of the upper subbasin impaired by AMD.

The USGS studied Swatara Creek watershed in 1992 and 1995 as part of its nationwide National Water Quality Assessment Program (NAWQA). Results of this investigation indicated that nutrient concentrations in streams were high and often exceeded drinking water standards. Nitrate concentrations in water wells in the limestone areas were among the highest in the nation and detected pesticide concentrations were high compared to the national average. One of the study units for the NAWQA project was located on Bachman Run. Results of the studies indicated that Bachman Run was among the highest 25% nationwide for elevated nutrients including nitrates, phosphates and ammonia. Fish and stream aquatic habitat was also degraded.

Abandoned Mine Drainage (AMD):
Upper Swatara Creek watershed flows through the southern-most area of the anthracite coal field of eastern PA which was heavily mined through the late 19th and early 20th centuries. Deep underground tunnel systems extended for miles. After the mines were abandoned, the tunnels filled with water and many formed surface discharges. Many of these tunnel discharges are very large and are responsible for much of the water quality impairment in the region. The major sources of AMD are in the Lorberry Creek and Good Spring Creek watersheds.

The upper Swatara Creek watershed has been degraded by AMD for over 150 years. Over 100 discharges from deep mine openings, culm piles and surface mines have been identified. Nine major mine pools underlie the upper watershed; four pools contain over 1.8 million gallons of contaminated water. The pH of the water exiting the mines is below neutral in most instances and iron precipitate coats the substrate downstream of the discharges. Reclamation projects have resulted in significant decreases in the chemical effects of the discharges. The biological community has also improved; however, affected streams generally still have low diversity and abundance of macroinvertebrates. The numbers and diversity of fish species have been increasing steadily each year at the Ravine, the downstream limit of the mined area. Water quality summaries and loadings can be found in the TMDL for upper Swatara Creek prepared by the Department and approved by EPA in 1999. A report by Dan Koury of the DEP Pottsville District Mine Office (DMO) (the Upper Swatara Creek Restoration Plan) summarized sources of water quality degradation and watershed restoration activities and their effects on in the various subwatersheds. A summary of the report is at the end of this WRAS.

Future threats to water quality
The upper watershed should improve with the installation of additional treatment systems to address abandoned mine discharges. Impacts from agriculture should decrease in surface waters if installations of BMPs by the watershed associations continue. The increasing population and the expanding urban areas in the lower two-thirds of the subbasin has the potential to increase impairment from urban runoff.

Nonresidential development, which includes office, industrial, and commercial development, is booming due to due to the interstate highways that pass through the subbasin. This type of development has a high potential for impact on surface and groundwater resources from massive site grading, removal of vegetation, and large paved 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.

Urbanization and paving can have a severe effect on stream aquatic life. Studies by the Maryland Department of Natural Resources showed 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
Remediation projects started or completed up to January 1999 in the AMD affected upper Swatara Creek watershed are listed in the summary of the Upper Swatara Creek Watershed Rehabilitation Plan at the end of this WRAS.

Pennsylvania Growing Greener Grants:

- $174,606 (FY2003) to Tremont Borough: This project will combine Office of Surface Mining and Growing Greener funds for Phase 2 of rehabilitation efforts on Goodspring and Middle Creeks, thus restoring 1,300 feet of stream channel.
- $272,290 (FY2002) to Lebanon Valley Conservancy for Phase II of the project is the design Phase. It is focused on designing specific restoration projects and best management practices identified in Phase I.
- Swatara Creek Watershed Association (FY2001):
    - $5,100 for water conservation kits.
    - $4,949 for Swatara contours.
    - $175,000 for reduction of nonpoint source pollution from agricultural sources.
- $85,000 (FY2001) to Northern Lebanon School District for the Northern Lebanon watershed awareness program.
- $109,840 (FY2001) to Tremont Borough for Good Spring Creek and Middle Creek watershed assessments and phase 1 rehabilitation.
- $133,314 (FY2000) to Camp Central for installation of a 775-foot riparian buffer around a lake at a camp used largely by disadvantaged youth. Stream restoration work will be incorporated into the environmental education program of the camp.
- $44,952 (FY2000) to the Swatara Creek Watershed Association (SCWA) to provide state of the art, user friendly website for the Swatara Creek watershed. The site will combine SCWA website, GIS mapping, the Rivers Conservation plan for the watershed, and links to other pertinent websites.
- $175,000 (FY2000) to the Swatara Creek Watershed Association Inc. to conduct a fluvial geomorphology assessment and evaluation of the Quittapahilla Creek watershed and to develop plans and priorities for stream restoration using natural stream design techniques.
- $82,000 (FY2000) to Northern Lebanon School District to partner with the Swatara Creek Watershed Association, Conservation Districts and other groups in watershed to prepare an environmental

education curriculum for their school district. The proposal for the first year to immerse entire K-12 school district in watershed activities, as well as involve the parents and community. The program will expand to other schools in the Swatara Creek Watershed in the second year. Age appropriate activities are planned including restoration, protection, stream sampling, and holding Watershed Awareness Weeks and Watershed Expos to educate the community about nonpoint source pollution problems and watershed stewardship.
- $19,500 (FY2000) to the Schuylkill County Conservation District to stabilize over 500 feet of eroding streambank in the upper Little Swatara Creek watershed, using bioengineering techniques and riparian plantings. Volunteers with several local conservation groups and high schools will assist.
- $3,875 (FY1999) to the Swatara Creek Watershed Association to help with the formation of a watershed association in the Little Swatara Creek watershed.

U.S. Environmental Protection Agency (EPA) Clean Water Act Section 319 Grants:
- $355,410 (FY2003) to Lebanon County Conservation District for continuing installation of agricultural best management practices (BMP's) in farms in Swatara Creek watershed.
- $117,825 (FY2003) to Schuylkill County Conservation District for repair of a limestone drain passive treatment system and continuing research and monitoring of the Swatara Creek watershed and treatment system efficiency by USGS.
- $171,436 (FY2001) to Lebanon County Conservation District for installation of agricultural best management practices (BMP's) in farms in the Swatara Creek watershed. BMP's will include manure storage systems, treatment of runoff from animal confinement areas, stream fencing, and treatment of milk house waste.
- $27,440 (FY2001) to the Quittapahilla Creek Watershed Association for stream fencing to exclude free cattle access along three stream miles and incorporate tree and shrub plantings on the Little Swatara Creek.
- $31,000 (FY2001) to the Northern Swatara Creek Watershed Association for modifications and routine maintenance of previously constructed abandoned mine drainage (AMD) passive treatment systems in the upper Swatara Creek watershed.
- $240,200 (FY2001) to the City of Lebanon Bureau of Public Works to construct passive treatment systems to treat AMD discharges to the Siegrist Reservoir, a water supply for the City of Lebanon.
- $108,529 (FY98) to Schuylkill County Conservation District for remediation of AMD on the Rowe Tunnel discharge to Lorberry Creek, the second largest discharge in upper Swatera Creek watershed.
- $40,000 (FY98-01) to U.S. Geological Survey (USGS) for the Swatara Creek National Monitoring Project to evaluate the effects of the AMD treatment systems installed and the potential for additional treatment systems in the upper Swatara Creek watershed. This was the first EPA National Monitoring Project for the study abandoned mine drainage.
- $75,750 (FY96) to Schuylkill County Conservation District for remediation of AMD on upper Swatara Creek.
- $137,145 (FY94) to U.S. Geological Survey for experimental remediation and evaluation of AMD anoxic and oxic limestone drains treatment systems on upper Swatara Creek.

U.S. Environmental Protection Agency (EPA) Clean Water Act Section 104b3 Grants:
- $101,476 (FY94) to USGS for AMD treatment at Lorberry Creek and for limestone treatment in upper Swatara Creek.
- $67,000 (FY96) to USGS for development and assessment of AMD treatment systems in upper Swatara Creek.
- $58,000 (FY97) to USGS for development and assessment of AMD treatment systems in upper Swatara Creek.
- $58,000 (FY94) to Schuylkill Conservation District for construction of AMD treatment systems in upper Swatara Creek.

DEP Bureau of Mining and Reclamation WRPA Grant Program:

- $32,000 (FY99) to Schuylkill Conservation District for construction of an oxic limestone drain AMD treatment system in upper Swatara Creek.

Department of Environmental Protection Bureau of Abandoned Mine Reclamation Abandoned Mine Lands (AML) Fund:

- $322,795 for construction of the Lorberry Junction AMD treatment system on upper portion of Lower Rausch Creek for treatment of AMD in the upper Swatara Creek watershed.

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

- $47,000 (1997) to the Swatara Creek Watershed Association to develop a rivers conservation plan for the Swatara Creek watershed.

Pennsylvania Watershed Restoration Assistance Program (WRAP):

- $36,950 to the Quittapahilla Creek Watershed Association for stream fencing in the Quittapahilla Creek watershed.
- $28,900 to the Quittapahilla Creek Watershed Association for stream restoration in Quittapahilla Creek watershed.

Pennsylvania Fish and Boat Commission Adopt-a-Stream Program:

- $2,000 to the Quittapahilla Creek Watershed Association for stream restoration in Quittapahilla Creek watershed.

U.S. Fish and Wildlife Service:

- $10,000 to the Quittapahilla Creek Watershed Association for stream restoration in Quittapahilla Creek watershed.

(DEP) Act 167 Stormwater Management Plans:

- Beaver Creek, Bow Creek, Manada Creek, and Kellock Creek have approved plans.

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 Swatara Creek Watershed Association has as a mission the promotion and conservation of the natural resources of Swatara Creek watershed. More information on their activities can be found on their web site at http://www.mbcomp.com/swatara.
- The Northern Swatara Creek Watershed Association was formed in 2000 to lead the remediation and protection of the upper Swatara Creek watershed in the coal mined portion upstream of Ravine.
- The Quittapahilla Creek Watershed Association is dedicated to improving the water quality and community awareness of the watershed. More information on their activities can be found on their web site at http://community.pennlive.com/cc/quittiewatershed.
- The Manada Conservancy is a local land trust dedicated to the protection and preservation of the natural, historic, agricultural and scenic resources of the Manada Creek and Swatara Creek basins. More information on their activities can be found on their web site at http://www.manada.org/.

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 stream assessments are completed and necessary TMDL's are developed for the watershed. The TMDL has been completed for the upper Swatara Creek (AMD impaired portion). Draft TMDL's have been prepared for the Quittapahilla Creek, Earlakill Creek, Bachman Run and Beck Creek, and Deep Creek watersheds. Existing programs addressing nonpoint source issues in the watershed will continue to move forward until all TMDL's are completed for the subbasin.

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 TMDL for Upper Swatara Creek Watershed</u>:
A Total Maximum Daily Load (TMDL) was prepared for stream segments in the upper portion of the Swatara Creek watershed to address the impairments noted on the 303(d) list caused by high levels of metals, and in some areas, the runoff of suspended solids from abandoned coal mines. The TMDL addresses the three primary metals associated with acid mine drainage, iron, manganese, and aluminum, as well as suspended solids. There are discrepancies in impairment causes listed for some upper Swatara Creek tributaries between the 1996/1998 303d lists that formed the basis of this TMDL and the 2000 305b list which is summarized in the table at the end of this WRAS.

Few mining operations in the watershed are actively pumping and treating water. Almost all of the discharges in the watershed are from abandoned mining operations and are, therefore, treated as nonpoint sources. The distinction between nonpoint and point sources is determined on the basis of whether or not there is a responsible party for the discharge. Discharges with no responsible party are considered a nonpoint sources. TMDL's were expressed as long-term average loadings, which give a better representation of the data used for the calculations due to the nature and complexity of mining effects on the watershed.

Applicable Water Quality Criteria			
Parameter	Criterion Value (mg/l)	Duration	Total Recoverable/ Dissolved
Aluminum	0.75	Maximum	Total Recoverable
Iron	1.50 0.3	1 day average maximum	Total Recoverable Dissolved
Manganese	1.00	maximum	Total Recoverable
Total Suspended Solids	NA	NA	NA

The TMDL was developed using the value of 0.75 mg/l as the instream criteria for aluminum, the EPA national acute fish and aquatic life criterion for aluminum. Pennsylvania is proposing to delete its current aluminum criterion and adopt the EPA national acute fish and aquatic life criteria of 0.75 mg/l. Pennsylvania's current aluminum criterion is 0.1 of the 96 hour LC-50 and is contained in PA Title 25 Chapter 93. PA has water quality criteria for the other metals listed; however, no water quality criterion exists for suspended solids. Suspended solids were evaluated from instream measurements and were shown before and after abatement projects specifically designed to reduce suspended solids. Biological survey results are the indicator used for determining recovery from impairment due to suspended solids.

Lorberry Creek Watershed:
The Lorberry Creek watershed is comprised of the main stem and a tributary, Stumps Run, which are impaired by low pH, suspended solids and metals. The most significant contributor of impairment is an abandoned deep mine discharge from the Rowe Tunnel, which makes up over 75% of the flow to the headwaters of Lorberry Creek. The Rowe Tunnel has been listed as the 2nd largest contributor of iron loading to the entire Swatara Creek basin. The two other major influences on Lorberry Creek are Stumps Run, which provides some assimilation capacity, and the fairly new Shadle discharge, which is from an active mine and, therefore, considered a point source discharge with a waste load allocation. No known pollutant sources exist downstream of the Shadle discharge.

The suspended solids (TSS) problem is caused by coal silt being washed into the stream during storm events and the flocculation of iron particles. The Rowe Tunnel and Stumps Run are the major contributors of TSS to Lorberry Creek. Concentrations of TSS have been recorded as high as 1600 mg/l in Lorberry Creek. Total solids have been reduced by changes in the mining practices of one of the coal mine operators at the headwaters of Lorberry Creek and other recent reclamation projects; however, solids and iron floc are still present.

Lower Rausch Creek:
Low pH, siltation, and metals from a number of abandoned seeps and mine discharges impair Lower Rausch Creek. Due to the discharge locations, their high volume and physical characteristics, treatment of individual abandoned discharges is not economically feasible. A wetland treatment system was constructed near the mouth of the stream with to treat AMD in the whole stream. Data sampling point Swat-17, located on Lower Rausch Creek immediately upstream of the wetland, was used in the TMDL to characterize the stream prior to treatment.

Middle Creek Watershed:
The Middle Creek watershed is composed of the main stem and four tributaries, Good Spring Creek, Coal Run, Gebhard Run and Poplar Creek. Cumulative loads from the 4 tributaries were used in the loading analysis of the main stem of Middle Creek. Due to the many years of mining and stream diversions, the topographic maps no longer accurately show the locations Coal Run and Gebhard Run.

Good Spring Creek:
Good Spring Creek is impaired by siltation and metals from abandoned deep mine discharges. The most significant pollution source is the Tracey Airhole, the primary drainage point for the Good Spring #3 mine pool. This discharge contributes the largest amount of iron loading to entire upper Swatara Creek watershed and masks the effects of other discharges in the watershed. The most feasible treatment option being considered is diversion of the discharge out of the subbasin and to the Rausch Creek AMD Treatment Plant in the Wiconisco Creek watershed. The TMDL analysis considered both diversion of the discharge and the option to provide treatment necessary to keep the discharge flowing into Good Spring Creek.

Two other pollutant sources were evaluated in the TMDL, the John Behm Tunnel (GS-3) and sample point GS-7 at the mouth of an unnamed tributary of Good Spring Creek, which contains two abandoned discharges. GS-7 was treated as a single discharge point for the purpose of expressing a load allocation above that point.

Gebhard Run:
Gebhard Run was listed as impaired by metals on the 1996 303d list; however, a biological survey under the DEP unassessed waters program conducted in 1998 showed that the stream segment was not impaired and no TMDL was developed. (Note: the 2000 305b list indicates that Gebhard Run was impaired by low pH.)

Coal Run:
Coal Run is on the 303(d) list for impairment due to metals from AMD. Some confusion exists with the stream hierarchy for the Middle Creek watershed. The topographic map shows the location of the Coal Run as the upper section of the main stem of Middle Creek; however, Coal Run joins the main stem of Middle Creek just above the town of Tremont.

Main Stem Middle Creek:
The main stem of Middle Creek is on the 303(d) list for impairment due to low pH and metals. Swat-21, located on the upper portion of Middle Creek, characterizes the main stem above its confluence with Gebhard Run. No other known pollutant sources exist on the main stem below point Swat-21. The downstream influences on Middle Creek are Gebhard Run, which is not impaired, and Coal Run, which has a separate TMDL. The TMDL for Middle Creek consists of a load allocation above point Swat-21.

Main Stem Swatara Creek:
The main stem of Swatara Creek is on the 303(d) list for impairment due to metals. Included in this analysis are one unnamed tributary (locally named Polly's Run) and Panther Creek which are also on the 303(d) list. Sample point Swat-15 was used to characterize the main stem Swatara Creek above the confluence of Polly's Run. TMDL's were developed for the main stem using sample points Swat-15, SW-6 (Polly's Run), and Swat-16 (Panther Creek).

Summary of Allocations:
This TMDL focused on the identified numerical reduction targets for each watershed. The attached Upper Swatara Creek Restoration Plan contains a listing and description of completed and proposed remediation projects in the watershed. Each project has or will have before and after monitoring done to determine remediation technique efficiencies. The TMDL will be reevaluated after additional restoration projects are completed and water quality changes occur.

Upper Swatara Creek Watershed
Estimated reductions identified for all points in the watershed

		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	load (lbs/day)	LTA Conc (mg/l)	load (lbs/day)	% reduction
Swat-04	**Rowe Tunnel discharge at headwaters of Lorberry Creek**					
	Al	1.01	21.45	0.27	5.79	73%
	Fe	8.55	181.45	0.77	16.33	91%
	Mn	2.12	44.95	0.49	10.34	77%
Swat-11	**Instream monitoring point on Stumps Run**					
	Al	0.08	0.24	0.08	0.24	0%
	Fe	0.18	0.51	0.18	0.51	0%
	Mn	0.09	0.27	0.09	0.27	0%
L-1	**Point source discharge to Lorberry Creek (active coal mine)**					
	Al	34.90	9.03	6.63	1.71	81%
	Fe	6.00	1.55	6.00	1.55	0%
	Mn	4.00	1.03	4.00	1.03	0%
Swat-17	**Instream monitoring point on Lower Rausch Creek above the treatment wetland**					
	Al	1.03	4.49	0.19	0.81	82%
	Fe	2.87	12.53	0.72	3.13	75%
	Mn	1.46	6.36	0.60	2.61	59%
GS-3	**John Behm Tunnel discharge to Good Spring Creek**					
	Al	0.48	1.61	0.48	1.61	0%
	Fe	6.47	21.79	2.33	7.85	64%
	Mn	1.31	4.40	1.31	4.40	0%
GS-7	**Instream monitoring point on unnamed tributary to Good Spring Creek**					
	Al	0.35	1.95	0.35	1.95	0%
	Fe	2.35	13.17	2.35	13.17	0%
	Mn	0.75	4.21	0.75	4.21	0%
Swat-20	**Instream monitoring point on Coal Run**					
	Al	0.32	3.66	0.26	2.92	20%
	Fe	1.71	19.47	0.67	7.59	61%
	Mn	1.08	12.25	0.65	7.35	40%
M-5	**Abandoned discharge to Coal Run**					
	Al	0.18	0.49	0.18	0.49	0%
	Fe	3.05	8.20	1.00	2.71	67%
	Mn	1.24	3.35	0.97	2.61	22%
M-6	**Abandoned discharge to Coal Run**					
	Al	0.18	0.49	0.18	0.49	0%
	Fe	9.23	24.85	1.38	3.73	85%
	Mn	1.95	5.26	0.98	2.63	50%
Swat-21	**Instream monitoring point on Middle Creek**					
	Al	1.02	20.96	0.44	9.06	57%
	Fe	2.18	45.06	0.83	17.10	62%
	Mn	1.07	21.99	0.63	12.99	41%
Swat-15	**Instream monitoring point on Swatara Creek**					
	Al	0.81	12.92	0.10	1.55	88%
	Fe	0.48	7.70	0.17	2.77	64%
	Mn	0.39	6.14	0.39	6.14	0%
SW-6	**Instream monitoring point at mouth of unnamed tributary to Swatara Creek**					
	Al	0.93	7.57	0.31	2.50	67%
	Fe	1.84	14.87	0.70	5.65	62%
	Mn	2.67	21.59	0.43	3.45	84%

Swat-16	**Instream monitoring point at mouth of Panther Creek**					
	Al	0.69	12.83	0.42	7.83	39%
	Fe	0.85	15.78	0.85	15.78	0%
	Mn	0.71	13.24	0.56	10.46	21%

Additional information and methods of load allocation calculations can be found in the Final TMDL on the Department's website at http://www.dep.state.pa.us/, choose directLINK, TMDL, Swatara Creek.

Summary of TMDL for Quittapahilla Creek Watershed:
Total Maximum Daily Loads (TMDL's) were developed to address impairments to the aquatic life present in the Quittapahilla Creek watershed. Excessive sediment and nutrient loads resulting from agricultural activities have been identified as the primary causes of impairments. The entire main stem and all tributaries are on the 303(d) list.

Protected uses of the Quittapahilla Creek watershed include aquatic life, water supply, and recreation. The entire basin is designated as Trout Stocking in the Department's Chapter 93. Land use in the basin is dominated by agriculture (67%). Development covers nearly 13% of the basin, with the city of Lebanon and Palmyra Borough the largest urban areas. Slightly more than 18% of the Quittapahilla Creek basin can be described as open space, including forest, wetlands, and water bodies.

Chemical sampling and biological surveys conducted in the Quittapahilla Creek watershed have clearly identified aquatic life use impairments due to extensive agricultural activities. Lack of riparian vegetation, pastures and croplands extending up to the streambank, and unrestricted livestock access have resulted in excessive levels of sediment and nutrients in surface waters. Excess nutrients cause increased algae growths and large quantities of streambed sediment deposits degrade benthic macroinvertebrate habitat.

The Quittapahilla Creek watershed was surveyed in 1999 as part of the Department's ongoing unassessed waters program. Ninety five percent of the 88.91 stream miles in the Quittapahilla Creek watershed (84.78 miles) were identified as impaired. Only 1.82 miles of stream (2%) were found to be supporting the designated aquatic life uses. The identified sources of use impairment were agriculture, crop related agriculture, urban runoff/storm sewers, and bank modification. Causes of impairment include nutrients, siltation, suspended solids, organic enrichment/low dissolved oxygen (D.O), flow alterations, and other habitat alterations. Agriculture was identified as the sole source for 40.19 (47%) of the impaired miles. Agriculture and urban runoff/storm sewers were listed as the sources of impairment for 27.13 miles (32%). Only 17.46 miles (21%) of impaired stream segments in the Quittapahilla Creek watershed are not impaired by agricultural sources.

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 stream animals use oxygen during the day. Excessive nutrient input can lead to elevated levels of algal 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, results in lower dissolved oxygen levels in streams.

SOURCES AND CAUSES OF IMPAIRMENTS IN THE QUITTAPAHILLA CREEK BASIN BASED ON THE 2000 305(b) REPORT		
SOURCE(S)	**CAUSE(S)**	**MILES IMPAIRED**
Agriculture	Nutrients	23.87
Crop Related Agriculture	Siltation	6.92
Agriculture	Flow Alterations & Siltation	9.40
Agriculture Urban Runoff/Storm Sewers	Flow Alterations & Siltation Flow Alterations	23.04
Agriculture Urban Runoff/Storm Sewers	Suspended Solids Organic Enrichment/Low D.O.	4.09
Urban Runoff/Storm Sewers	Flow Alterations	6.44
Bank Modifications Urban Runoff/Storm Sewers	Other Habitat Alterations Flow Alterations	11.02

The TMDL's developed for the Quittapahilla Creek watershed address agriculture related impairments caused by nutrients, siltation and suspended solids. A TMDL for phosphorus was chosen to address the nutrient impairments because it is the limiting nutrient in the watershed. A sediment TMDL will address the siltation listings. Those segments listed for impairments due to suspended solids will be addressed through the sediment and phosphorus TMDL's. Total suspended solids (TSS) include both an inorganic and an organic component. The sediment TMDL will reduce the inorganic portion of the suspended solids, while the organic fraction of TSS is addressed through the prescribed phosphorus reductions. The TMDL does not address any 303(d) listings for the category of flow alterations. TMDL's are not the appropriate mechanism to address this type of stream impairment because TMDL's are designed to address pollutant loadings that cause water quality standards to be exceeded.

Pennsylvania presently does not have water quality criteria for nutrients and sediments; therefore, a reference watershed approach was developed to identify the TMDL endpoints or water quality objectives for nutrients and sediments in the impaired segments of Quittapahilla Creek watershed. The nutrient loading for this watershed only addresses phosphorus because phosphorus was determined to be the limiting nutrient. Phosphorus is generally held to be the limiting nutrient in a waterbody when the nitrogen/phosphorus ratio exceeds 10 to 1. In the Quittapahilla Creek watershed, the N/P ratio is approximately 17, which points to phosphorus as the limiting nutrient. Controlling the phosphorus loading to surface waters in the Quittapahilla Creek watershed will limit plant growth, thereby helping to eliminate use impairments currently caused by excess nutrients.

Three factors were considered in selecting a suitable reference watershed. The first factor is to use a watershed that has been assessed by the Department using the Unassessed Waters Protocol and has been determined to attain water quality standards. The second is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, ecoregion, and geology. Finally, the size of the reference watershed should be within 20-30% of the impaired watershed area. A watershed that would satisfy all the characteristics mentioned above could not be found in the same ecoregion as Quittapahilla Creek because not all stream segments in the Northern Piedmont Ecoregion where Quittapahilla Creek watershed is located have been assessed and all watersheds that have similar levels of agricultural land use and geologic rock type distributions as Quittapahilla Creek watershed were also determined to be impaired. A portion of the Conococheague Creek watershed located near Chambersburg in Franklin County was used as a reference for the Quittapahilla Creek watershed. The Conococheague Creek watershed is located in the Ridge and Valley Ecoregion in State Water Plan (SWP) Subbasin 13C.

Most of Conococheague Creek watershed stream segments have been assessed and were found to be unimpaired. This watershed has an area of 62.6 square miles or 81% of the Quittapahilla Creek watershed area and land cover/use distributions in both watersheds are similar. The agricultural land use, which is one of the primary sources of impairment in the Quittapahilla Creek watershed, accounts for 67% of the total land area as compared to 84% in Conococheague watershed. Surface geology in the Quittapahilla Creek and Conococheague Creek watersheds were also compared. The geology of Quittapahilla Creek watershed consists primarily of carbonate (72%) and interbedded sedimentary rocks (17%) with lesser amounts of metamorphic/ igneous (4%), shale (4%), and conglomerate (3%). The Conococheague Creek watershed is comprised of carbonate (63%) and shale (37%). Bedrock geology primarily affects surface runoff and background nutrient loads through its influences on soils, landscape, fracture density, and directional permeability. These watersheds are very similar in terms of average runoff, precipitation, and soil K factor.

General observations and comparisons of the individual watershed characteristics:

- Quittapahilla Creek Watershed
  - -Less topographic relief
  - -Dominated by carbonate rocks
  - -Cropland primarily continuous corn (no rotation) or only a corn-soybean rotation
  - -Lack of strip cropping
  - -Severely limited riparian buffers, with many exposed and eroding banks
  - -Pastures and cropland extending up to streams and roads
- Conococheague Creek Watershed
  - -More topographic relief
  - -Dominated by carbonate rocks
  - -More hay/pasture and cover crops
  - -More crop residue left
  - -More use of strip cropping and forest buffers along streams
  - -More evidence of conservation practices and lower animal densities

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 intensity development, high intensity development, quarries, groundwater, and septic systems.

The Quittapahilla Creek watershed TMDL's are allocated to point sources (phosphorus only) and nonpoint sources, with 10% of the TMDL reserved as a margin of safety (MOS). The TMDL's developed for the Quittapahilla Creek watershed establish a 73% reduction in the current sediment loading of 36,740,900 pounds per year and a 19% reduction in the current phosphorus loading of 70,973 pounds per year.

Existing sediment and phosphorus loadings in the Quittapahilla Creek watershed are 36,740,900 and 70,973 pounds per year, respectively. Based on a comparison to the similar, unimpaired watershed, the maximum sediment loading that would still allow water quality objectives to be met in the Quittapahilla Creek watershed is 9,812,695 pounds per year. Phosphorus loading needs to be limited to 57,247 pounds per year. Reducing sediment and phosphorus loads to the TMDL's identified should allow the Quittapahilla Creek watershed to support its designated aquatic life uses.

TMDL VALUES FOR THE QUITTAPAHILLA CREEK WATERSHED			
POLLUTANT	**LOADING RATE IN REFERENCE WATERSHED (lbs./acre/yr.)**	**QUITTAPAHILLA CREEK WATERSHED AREA (acres)**	**TARGET TMDL VALUE (lbs./yr.)**
Sediment	200.55	48,928.92	9,812,695
Phosphorus	1.17	48,928.92	57,247

Agricultural practices that approximate the conditions in the reference watershed Conococheague Creek and installation of appropriate best management practices (BMPs) should reduce nutrient loading and help achieve water quality standards. Since sediment and phosphorus reductions in the TMDL's are allocated entirely to agricultural activities in the watershed, implementation of best management practices (BMPs) in the affected areas 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.

An excellent start has already been made in the implementation of BMPs in the Quittapahilla Creek basin. The local watershed association began installing streambank fencing, stable livestock crossings, and planting of riparian vegetation in 1999. Visits to a number of these sites in 2000 and indicated noticeable reductions in the severity of streambank erosion and sediment deposition have already occurred. Further visits will be made to assess 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 outlined in the TMDL.

Additional information and loadings calculated for individual land use categories can be found in the Draft TMDL on the Department's website at http://www.dep.state.pa.us/, choose directLINK, TMDL, Quittaphilla Creek.

<u>Summary of TMDL for Earlakill Creek Watershed</u>:
Earlakill Run is located approximately two miles east of Fredricksburg Borough in Lebanon County. U.S. Route 22 and Interstate 78 cross the main stem of Earlakill Run in the middle of the watershed. The stream originates in Bethel Township and flows for 4.1 miles to its confluence with Little Swatara Creek near Mt. Zion. A total of 5.4 miles of streams flow through the watershed, including 3 unnamed tributaries. Land use is dominated by agriculture (90%); other land uses are limited and include forest (6%), development (3%), and wetlands and water bodies (1%). Protected uses of the Earlakill Run watershed include aquatic life, water supply, and recreation. The entire basin is currently designated as Warm Water Fishes in the Department's Chapter 93.

The Department's 2000 305(b) report indicates that all 5.43 stream miles in the Earlakill Run watershed are impaired by agricultural activities. Nutrients are reported as the cause of impairment in the main stem, while nutrients and siltation are identified as the impairment cause in all of the unnamed tributaries. Surveys conducted by the Department in the Earlakill Run watershed y identified aquatic life use impairments due to extensive agricultural activities including lack of riparian vegetation, pastures and croplands that extended up to streambanks, and unrestricted livestock access to streams, which have resulted in excessive levels of sediment and nutrients. Streambank erosion is extensive, particularly in the many areas where livestock have unrestricted access to streams. Excess nutrients cause increased algae growths and sediment deposited in large quantities on the streambed degrade the habitat for benthic macroinvertebrates.

Total Maximum Daily Loads (TMDL's) for sediment and total phosphorus were developed to address excessive siltation and nutrient loads resulting from agricultural activities identified as causes of impairments. A sediment TMDL was developed to address impairments from siltation.

Pennsylvania does not currently have water quality criteria for sediment and nutrients; therefore, TMDL endpoints for sediment and nutrients were identified using a reference watershed approach described above under the Quittapahilla Creek TMDL. The comparison watershed used was Lick Run in the Ridge and Valley Ecoregion in Colombia County, in State Water Plan Subbasin 05E. These watersheds are similar in terms of geology, land use, average runoff, precipitation, and soil K factor.

Comparison of the two watersheds:

- Earlakill Run Watershed
  -Cropland primarily continuous corn (no rotation) or only a corn-soybean rotation.
  -Lack of strip cropping.
  -Severely limited riparian buffers, with many exposed and eroding banks.
  -Pastures and cropland extending right up to streams and roads.
- Lick Run Watershed
  -Higher rate of soil conservation practices including use of winter wheat, leaving crop residue after harvest, use of strip cropping, and stream bank fencing.
  -Presence of forested riparian buffers along streams.
  -More evidence of overall conservation practices and lower animal densities.

All impairments in the Earlakill Run watershed result from agricultural activities. Those caused by siltation were addressed by reducing the sediment loading; impairments caused by nutrients were addressed by reducing phosphorus loading. In most freshwater systems, phosphorus is the limiting nutrient for aquatic growth. If the N/P ratio is greater than 10, phosphorus is the limiting nutrient. In the Earlakill Run watershed, the N/P ratio is approximately 16, which points to phosphorus as the limiting nutrient. Controlling the phosphorus loading to surface waters in the Earlakill Run watershed will limit plant growth, thereby helping to eliminate impairments caused by excess nutrients.

The TMDL was developed using the Generalized Watershed Loading Function (GWLF) model described above. The Earlakill Run watershed TMDL's are allocated entirely to nonpoint sources. The TMDL's developed for the Earlakill Run watershed establishes a 29% reduction in the current sediment loading of 2,355,945 pounds per year and a 41% reduction in the current phosphorus loading of 3,396 pounds per year. Based on comparisons with the reference watershed, the maximum sediment loading that would allow water quality objectives to be met in the Earlakill Run watershed is 1,674,743 pounds per year. Phosphorus loading needs to be limited to 1,997 pounds per year. Reducing sediment and phosphorus loads to the TMDL's identified should allow the Earlakill Run watershed to support its designated aquatic life uses. Allocations of the sediment and phosphorus TMDL's are summarized below.

Summary of TMDL's for the Earlakill Run Watershed (lbs./yr.)						
Pollutant	**TMDL**	**WLA**	**MOS**	**LA**	**LNR**	**ALA**
Sediment	1,674,743	0	167,474	1,507,269	24,882	1,482,387
Phosphorus	1,997	0	200	1,797	291.5	1,506

Unit area loading rates for sediment, total nitrogen, and total phosphorus were estimated for each watershed by dividing the mean annual loadings (lbs./yr.) by the total area (acres)(Tables 4 and 5). Unit area load estimates for sediment, total nitrogen, and total phosphorus in the Earlakill Run watershed are 849.35 lbs./acre/yr., 19.73 lbs./acre/yr., and 1.22 lbs./acre/yr., respectively. Unit area load estimates for sediment, total nitrogen, and total phosphorus in the Lick Run watershed are 603.77 lbs./acre/yr., 13.75 lbs./acre/yr., and 0.72 lbs./acre/yr., respectively.

TMDL Values for Earlakill Run Watershed			
Pollutant	**Earlakill Run Watershed Area (acres)**	**Loading Rate in Reference Watershed (lbs./acre/yr.)**	**Target TMDL Value (lbs./yr.)**
Sediment	2,773.81	603.77	1,674,743
Phosphorus	2,773.81	0.72	1,997

Sediment and Phosphorus Load Allocations & Reductions For Agricultural Land Uses in The Earlakill Run Watershed						
Land Use	**Acres**	**Current Loading Rate (Lbs./Acre/Yr.)**	**Allowable Loading Rate (Lbs./Acre/Yr.)**	**Current Load (Lbs./Yr.)**	**Load Allocation (Lbs./Yr.)**	**Percent Reduction**
Sediment						
Hay/Pasture	1,052.22	166.94	149.25	175,654.63	157,046	11%
Cropland	1,467.18	1,469.08	903.33	2,155,408.81	1,325,342	39%
Phosphorus						
Hay/Pasture	1052.22	0.30	0.25	314.10	260	17%
Cropland	1,467.18	1.90	0.85	2,790.75	1,246	55%

Sediment and phosphorus reductions in the TMDL's are allocated entirely to agricultural activities in the watershed. Implementation of best management practices (BMPs) in the affected areas and establishing agricultural practices that approximate the conditions in Lick Run and should reduce nutrient loading and help achieve water quality standards. 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. The effects of the existing BMPs will be evaluated and the most cost-effective and environmentally protective combination of BMPs required for meeting the sediment and nutrient reductions outlined in this report will be determined at a later date.

Additional information and loadings calculated for individual land use categories can be found in the Draft TMDL on the Department's website at http://www.dep.state.pa.us/, choose directLINK, TMDL, Earlakill Creek.

Summary of TMDL for Deep Run Watershed:
Deep Run is a tributary to Little Swatara Creek in Lebanon County, PA. Deep Run travels 5.1 miles from its source in Jackson Township to its mouth near Freeport Mills. Land use in the 6.2 square mile watershed is dominated by agricultural, including croplands and dairy cattle. The Deep Run basin is currently designated as Warm Water Fishes.

The Department's 2000 305(b) report database indicates that all 7.44 miles of streams in the Deep Run watershed are impaired by agricultural activities. A combination of nutrients and siltation were identified as the causes of impairment. Historical surveys conducted by the Department identified excessive siltation and nutrient loads resulting from agricultural activities as causes of impairments in the basin. Lack of riparian vegetation, pastures and croplands that extended right up to streambanks, and unrestricted livestock access to streams have allowed excessive levels of sediment and nutrients to reach surface waters. A 2000 site visit conducted as part of the TMDL development noted that unrestricted livestock access to streambanks and sediment deposited in large quantities on the streambed degraded the habitat of benthic macroinvertebrates.

Total Maximum Daily Loads (TMDL's) for sediment and total phosphorus were developed to address impairments noted in Pennsylvania's 1996 and 1998 303(d) lists. A sediment TMDL was developed to address impairments caused by siltation. The TMDL developed to address nutrient related impairments focuses on the control of total phosphorus, since it was determined to be the limiting nutrient in the watershed.

Pennsylvania does not currently have water quality criteria for sediment and nutrients; therefore, TMDL endpoints for sediment and nutrients were identified using a reference watershed approach. Lick Run was selected as the reference watershed for developing the Deep Run watershed TMDL's. Lick Run, a tributary to Roaring Creek in State Water Plan (SWP) Subbasin 5E, is located in the Ridge and Valley Ecoregion in Columbia County, PA. These two watersheds are similar in terms of geology, land use, average runoff, precipitation, and soil K factor. An evaluation by the Department in 1998 as part of its Unassessed Waters program determined that Lick Run was attaining its designated uses.

General observations of the individual watershed characteristics include:

- Deep Run watershed
  - -Croplands included a mixture of corn and soybean.
  - -Soil conservation techniques present in some cropland areas, incuding strip cropping and leaving crop residue after harvest.
  - -Forested riparian buffers limited to tributaries in upper portion of the basin.
  - -Severely limited riparian buffers in the middle and lower portions of the basin, with many exposed and eroding banks
  - -Pastures and barnyards extending up to streams, with unlimited livestock access.
- Lick Run watershed
  - -Higher rate of soil conservation practices including use of winter wheat, leaving crop residue after harvest, use of strip cropping, and streambank fencing.
  - -Presence of forested riparian buffers along the main stem and tributaries.
  - -More overall evidence of conservation practices and lower animal densities.

Phosphorus and sediment loading rates were computed using the AVGWLF model. Targeted TMDL values for sediment and phosphorus were determined by multiplying the total area of the Deep Run watershed (3,927.3 acres) by the unit area loading rates for the Lick Run watershed. The Deep Run watershed TMDL's are allocated entirely to nonpoint sources, with 10% of the TMDL reserved as a margin of safety (MOS).

TMDL Values For The Deep Run Watershed			
Pollutant	**Deep Run Watershed Area (acres)**	**Loading Rate In Reference Watershed (lbs./acre/yr.)**	**Target Tmdl Value (lbs./yr.)**
Sediment	3,927.3	603.77	2,371,186
Phosphorus	3,927.3	0.72	2,828

Existing sediment and phosphorus loadings in the Deep Run watershed are 3,251,863 and 4,853 pounds per year, respectively. Based on a comparison to a similar, unimpaired watershed, the maximum sediment loading that would still allow water quality objectives to be met in the Deep Run watershed is 2,371,186 pounds per year. Phosphorus loading needs to be limited to 2,828 pounds per year. Reducing sediment and phosphorus loads to the TMDL's identified should allow the Deep Run watershed to support its designated aquatic life uses. Allocations of the sediment and phosphorus TMDL's are summarized below:

Summary TMDL's for the Deep Run Watershed (lbs./yr.)						
Pollutant	**TMDL**	**WLA**	**MOS**	**LA**	**LNR**	**ALA**
Sediment	2,371,186	0	237,119	2,134,067	29,541	2,104,526
Phosphorus	2,828	0	283	2,545	352	2,193

Sediment and Phosphorus Load Allocations & Reductions for Agricultural Land Uses in Deep Run Watershed						
Land Use	**Acres**	**Current Loading Rate (lbs./acre/yr)**	**Allowable Loading Rate (lbs./acre/yr.)**	**Current Load (lbs./yr.)**	**Load Allocation (lbs./yr.)**	**Percent Reduction**
Sediment						
Hay/Pasture	1,358.50	244.34	211.05	331,938.33	28,6716	14%
Cropland	1,901.90	1519.73	955.79	2,890,383.26	18,17810	37%
Phosphorus						
Hay/Pasture	1,358.50	0.48	0.37	645.37	499	23%
Cropland	1,901.90	2.03	0.89	3,855.73	1,694	56%

Sediment and phosphorus reductions in the TMDL's are allocated entirely to agricultural activities in the watershed. Implementation of best management practices (BMPs) in the affected areas 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. Future assessments will be made of the extent of existing BMPs to determine the most cost-effective and environmentally protective combination of BMPs required for meeting the sediment and nutrient reductions outlined in the TMDL.

Additional information and loadings calculated for individual land use categories can be found in the Draft TMDL on the Department's website at http://www.dep.state.pa.us/, choose directLINK, TMDL, Deep Run.

Summary of TMDL's for Beck Creek and Bachman Run Watersheds:
Bachman Run and Beck Creek watersheds are tributaries of the Quittapahilla Creek in Lebanon County, PA. The protected uses of the watersheds are water supply, recreation and aquatic life. The aquatic use for both Bachman Run and Beck Creek is trout stocking fishes.

Total Maximum Daily Loads were developed for the Bachman Run and Beck Creek watersheds to address the impairments noted on Pennsylvania's 1996 303(d) List of Impaired Waters. Based on a 1989 chemical survey Bachman Run and Beck Creek watersheds were determined to not be meeting designated water quality uses for protection of aquatic life and placed on the 303(d) list. All 7.14 miles of Beck Creek are on the 303d due to nutrient impairment from agriculture. A total of 6.81 miles of the main stem and 2 unnamed tributaries of Bachman Run are on the 303d list due to nutrient and siltation from crop related agriculture.

The primary land use (81%) of the 15.7-square mile Bachman Run and Beck Creek watersheds is agriculture, with areas adjacent to the stream used for row crops and pasture. Cattle generally have had free access to the stream. The majority of the stream had no protected riparian zone during the 1989 DEP survey.

Since neither Pennsylvania nor EPA currently has water quality criteria for sediment or nutrients, a reference watershed approach was used to identify the TMDL endpoints or water quality objectives for nutrients and sediment in Bachman Run and Beck Creek. The reference watershed approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessment. 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 model. 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 non-impaired, reference stream segment. This load reduction will allow the biological community to return to the impaired stream segments.

Brubaker Run, a tributary of Chickies Creek in Lancaster County, approximately 12 miles south of Bachman Run and Beck Creek, was chosen as a reference watershed. Brubaker Run is similar in land cover/land use and size to both Bachman Run and Beck Creek watersheds. Brubaker Run was used as the reference watershed for the Donegal Creek TMDL. The TMDL for Bachman Run and Beck Creek follows a similar format as the Donegal TMDL.

Although Bachman Run and Beck Creek watersheds are very similar to the Donegal Creek in size and land use, the geological formations between the Bachman Run and Beck Creek watersheds and the Brubaker Run watershed differ. Bachman Run and Beck Creek watersheds contain carbonates and some metamorphic and igneous rocks. The Brubaker Run watershed is comprised of primarily sandstone and shale. A similar disparity was noted between Donegal Creek and Brubaker Run in the Donegal Creek TMDL. The GWLF water model used for the TMDL compensates for the disparity in the geology of the two watersheds with data that equates the differences. The bedrock geology influences soil type as well as fractures and directional permeability. Well data is used to calculate levels of nitrogen in groundwater to account for the difference of flow through various rock types.

The major differences between the comparison watersheds are as follows:
- Bachman Run and Beck Creek have less topographic relief, more hay pastures then row crops, more animals particularly livestock operations, dominated by limestone geology (more conducive to nitrogen leaching), less evidence of conservation practices.
- Brubaker Run has more topographic relief, more corn-hay rotations, more crop residue left, more use of strip cropping and stream buffers, fewer animals, dominated by shale and metamorphic rock (less conducive to nitrogen leaching).

The TMDL's proposes reducing the phosphorus and sediment loadings in Bachman Run and Beck Creek watershed to levels consistent with Brubaker Run watershed, the reference watershed. Because of the similarities in land use between the two watersheds, achieving phosphorus and sediment loadings in the Bachman Run and Beck Creek TMDL will ensure that the aquatic life use is achieved and maintained as evidenced in Brubaker Run.

The nutrient portion of this TMDL addresses only phosphorus because phosphorus was determined to be the limiting nutrient for plant growth in Bachman Run and Beck Creek. Phosphorus is generally held to be the limiting nutrient in a body of water when the nitrogen/ phosphorus ratio exceeds 10 to 1. The nitrogen to phosphorus ratio for Bachman Run and Beck Creek is 207,790 pounds of nitrogen to 19,900 pounds of phosphorus, or 10.4 to 1

The TMDL's established for Bachman Run and Beck Creek consist of a load allocation (LA) and a margin of safety (MOS) for both phosphorus and sediment. No wasteload allocation (WLA) was developed for this TMDL because there are no known point source discharges.

TMDL's for Bachman Run and Beck Creek				
Pollutant	**TMDL (lb/yr)**	**LA (lb/yr)**	**WLA (lb/yr)**	**MOS (lb/yr)**
Phosphorus	11,393	10,254	0	1,139
Sediment	942,667	848,400	0	94,267

Load Allocation by Land Use/Source									
		Phosphorus				**Sediment**			
Source		**Unit Area Loading Rate**	**Annual average load**	**LA (annual average)**	**% Reduc-tion**	**Unit Area Loading Rate**	**Annual average load**	**LA (annual average)**	**% Reduct-ion**
	Acres	**Lbs/acre/ year**	**lbs/year**	**lbs/year**		**lbs/acre/ year**	**lbs/year**	**lbs/year**	
Hay/Past	2916	1.26	3,669	2,136	42%	307.54	896,712	354,728	60%
Row Crops	628	2.09	1,310	763	42%	518.72	325,566	136,514	58%
Prob Row C	4633	2.51	11,607	4,041	65%	717.59	3,324,675	354,728	89%
Coniferous	99	0.00	0.44	0.44	0%	.27	26.5	26.5	
Mixed For	94	0.00	0.44	0.44	0%	.18	16.8	16.8	
Deciduous	1574	0.01	11.5	11.5	0%	1.52	2,387	2,387	
Lo Int Dev	94	0.09	8.6	8.6	0%		0	0	
Hi Int Dev	42	1.15	48.5	48.5	0%		0	0	
Quarry	0		0	0	0%				
Groundwater			3,227	3,227	0%				
Point Source			0	0	0%				
Septic Systems			17.0	17.0	0%				
Total	**10,082**	**1.97**	**19,899**	**10,254**	**49%**	**451.27**	**4,549,383**	**848,400**	**81%**

Additional information and loadings calculated for individual land use categories can be found in the Draft TMDL on the Department's website at http://www.dep.state.pa.us/, choose directLINK, TMDL, Bachman Run/Beck Creek.

The pollutant reductions in the TMDL's are allocated entirely to agricultural activities in the watershed. Implementation of best management practices (BMPs) in the affected areas should achieve the loading reduction goals established in the TMDL's. Remediation activities in the watershed have already begun. The primary remediation activities for the watershed are aggressive conservation practices applied to agricultural areas such as use of cover crops, crop rotations, conservation buffers, contour farming, strip cropping, and streambank stabilization and fencing. Stabilizing the streambank will reduce instream erosion. Fencing keeps livestock out of the stream and provides a riparian zone along the stream that traps sediment and phosphorus, keeping these pollutants from reaching the stream. These agricultural conservation practices improve water quality, reduce soil erosion, and water runoff.

The Quittapahilla Watershed Association and its affiliates began installing BMPs in 1998. Among the association's committed cooperative organizations are The Palmyra Sportsmen's Association; Trout Unlimited, Doc Fritchey Chapter; The Swatara Watershed Association; Indiantown Gap Fish and Game; The 2015th Engineer Flight Group of Indiantown Gap, Red Horse Outfit; Carmeuse, PA, Inc.; Boger and Son of Annville; Vortex Environmental; and Lebanon Valley College. The Lebanon County Conservation District, U.S. Fish and Wildlife and the U.S. Department of Agriculture are participating governmental entities.

Remediation Projects		
BMP or Alternative Activity	**Units Installed**	**Units Projected**
Streambank Fencing	11 farms/5 miles	4
Stream Crossings	2 farms	9 farms
Riparian Planting	7 farms/5 miles	5 farms
Other streambank stabilization devices	7 devices (2,105 ft)	16 devices
Work parties	3x 5.5 hour events	
Stream Clean-ups	4x 2-hour events	
Nutrient Management education	Materials distributed	
Monitoring and assessment (11 sites)	Every 6 months	Continuing through April 2000

Several monitoring programs have been established to document changes in stream health. The Quittapahilla Creek Watershed Association conducts streambed assessments and pebble counts every 6 months. Water quality and macroinvertebrate surveys are conducted at established sites by Lebanon Valley College. The data is sent to the U.S. Fish and Wildlife Service for analysis. The DEP Southcentral Regional Office Water Management Program has been collecting water chemistry samples and measuring flows on Bachman Run and Beck Creek since July of 1999. Their sampling efforts will continue throughout the implementation phase of the TMDL to determine if water quality is improving and recovery is taking place.

Updates on Watershed Projects

The Swatara Greenway Project:

An effort was begun in 1998 to protect the corridor along the entire length of Swatara Creek as a greenway. This project will recognize the importance of the river corridor as habitat for wildlife and endangered species and as a scenic or historic area. Most of the land along the creek is relatively undeveloped and privately owned. Some land is already protected in local parks, but other areas have been developed and have lost their protective buffer. Local organizations and agencies along the corridor have begun coordinating their protection efforts and have developed a formal plan to be followed. Partners in the project include The Manada Conservancy, The Conservation Fund, Dauphin County Parks and Recreation Department, Milton Hershey School, Milton Hershey School Trust, PA DCNR, and the Swatara Creek Watershed Association.

Quittapahilla Creek Watershed Assessment:
The Quittapahilla Creek Watershed Association (QCWA) received a Growing Greener grant to develop a watershed-wide approach to assessment and restoration. Clear Creeks Consulting was hired as their consultant to develop the plan. Land use in the watershed was examined to assess the differential impacts of urban development in some areas and farming in other areas. Since sediment and nutrients have been identified as significant problems in the watershed, quantifying the magnitude of the problems and identifying the sources of these pollutants became a major objective of the project. Through walking the length of the entire watershed, stream channel stability problems were identified. Maps were constructed based on this extensive empirical survey. These maps contain the documentation of the stream channel stability problems that are contributing to degraded water quality.

Hydrologic modeling was used to provide estimates of stream flow variability under different storm conditions. The modeling points out how changes in land use have affected stream channel stability and will allow QCWA to identify areas sensitive to flooding and areas that may be set aside for stormwater detention. Previous monitoring did not consider what is occurring in the stream during storm events. To identify the effects of storms, the volunteers will go out during storms to take measurements. To complement other measurements, the types of fish and insects present will be used to assess the health of the stream. Lack of aquatic life will help identify problem areas throughout the watershed. Volunteers are planting trees along Snitz Creek on a farm where a streambank fence had been installed. A watershed management and restoration plan will be completed within the next three years. A steering committee meets periodically to review the project.

References/Sources of information

- State Water Plan, Subbasin 7, Lower Susquehanna River. Department of Environmental Protection, February 1980
- USGS Topographic Maps
- Growing Greener and 319 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
- Rivers Conservation Plan for Swatara Creek Watershed. Swatara Creek Watershed Association. 1998.
- Draft and Approved TMDL's for Upper Swatara Cree, Quittapahilla Creek, Earlakill Creek and Bachman Creek and Beck Creek Watersheds. DEP Bureau of Watershed Conservation. 1999 & 2000.

Streams in Subbasin 07D, Swatara Creek: 303d/305b Listings

Stream	Stream Code	Drain-age area square miles	Miles Attained	Miles Impaired	Causes/Sources
2-**Swatara Creek**	09361	571	39.99, middle & lower main stem; 78.94, 97 UNTs	32.53, upper main stem. 77.28, 97 UNTs; 1.27, one UNT TMDL	Metals & pH from AMD Siltation, flow alterations, nutrients from crops related AG Siltation from Construction & AG
3-Panther Creek	10086	1.82		1.73 TMDL	Siltation from AMD
3-Middle Creek	10078	5.80		4.2 TMDL	Metals & pH from AMD
4-Coal Run	10083	1.27		0.8 TMDL	Metals from AMD
5-Gebhard Run	10084	2.06	1.99 main stem	1.75 main stem; 0.73, one UNT TMDL	pH from AMD
4-Good Spring Creek	10079	14.2		6.45 TMDL	Siltation from AMD
5-Poplar Creek	10080	0.87	1.39		
3-Black Creek	10077	6.31	6.75		
3-Lower Rausch Creek	10074	8.88		4.0 TMDL	Siltation & pH from AMD
4-Lorberry Creek	10075	4.21		2.07 TMDL	pH from AMD
5-Stumps Run	10076	0.65		0.62 TMDL	pH from AMD
3-Adams Run	10073	1.12	1.1		
3-Upper Little Swatara Creek & 12 UNTs	10054	24.3	27.27		
3-**Lower Little Swatara Creek**	10035	35.6	12.07 main stem; 21.32, 15 UNTs	9.38, 3 UNTs	Nutrients, siltation from AG
3-Swope Valley Run & 4 UNTs	10031	5.53	9.04		
3-Mill Creek at Suedberg & one UNT	10014	17.8	4.7		*EV*
4-Fishing Creek	10019	15.0	2.46		*EV*
5-West Branch Fishing Creek	10022	2.69	3.31		*EV*

5-Baird Run	10021	1.72	1.38		*EV*
5-Dehaas Run	10020	1.17	0.99		*EV*
4-Evening Branch	10016	6.89	4.97		*EV*
5-Gold Mine Run	10018	1.24	1.80		*EV*
5-Black Spring Creek	10017	0.92	1.45		*EV*
3-Bear Hole Run & one UNT	10012	3.13	4.58		
3-Trout Run	09988	8.62	2.52 main stem; 6.67, 10 UNTs	2.12 main stem; 1.56, 2 UNTs	Nutrients & Siltation from AG
3-Monroe Creek & 2 UNTs	09982	7.81	7.42		*HQ-CWF*
3-Forge Creek	09978	1.84		1.98 main stem; 1.50, 3 UNTs	Flow alterations, siltation from AG
3-Oil Creek	09969	3.60		3.55 main stem; 1.71, one UNT	Flow alteration, siltation from crop related AG
3-Red Run	09967	1.20		1.96	Flow alterations & Siltation from crop related AG
3-**Little Swatara Creek**	09888	99.2	25.89 main stem; 28.59, 22 UNTs	22.02, 13 UNTs	Nutrients, siltation from AG; organic enrichment from On site waste water
4-Stone Creek & one UNT	09958	2.88	4.19		
4-Mill Creek at Bethel & 2 UNTs	09950	3.06	4.12		
4-Crosskill Creek	09919	18.9	0.64 main stem; 15.41, 10 UNTs	3.96 main stem; 2.73, 2 UNTs	Pathogens, suspended solids, flow alterations, organic enrichment/low DO from AG & MUNI
5-Meck Creek & one UNT	09930	3.41	2.94		
4-Earlakill Run	09912	4.37		4.09 main stem; 1.34, 3 UNTs TMDL	Nutrients, siltation from AG

4-Deep Run at Freeport Mills	09909	6.21		5.1 main stem; 2.34, 3 UNTs TMDL	Nutrients, siltation from AG
4-Elizabeth Run	09891	9.89		1.41 main stem; 5.19, 4 UNTs; 0.5 main stem	Suspended solids, nutrients, siltation from AG Suspended solids & nutrients from IND & MUNI
5-Beach Run	09898	4.25		2.17 main stem; 5.19, 3 UNTs; 0.73 main stem	Siltation & nutrients from URB Siltation from AG
4-Deep Run at Federicksburg	09896	2.26		2.69 main stem; 0.69, one UNT TMDL	Suspended solids, nutrients, unknown causes from AG, URB, MUNI, IND
3-Reeds Creek	09820	9.30		3.02 main stem; 3.41, 6 UNTs	Flow alterations & siltation from AG
4-Aires Run	09824	2.23	2.45 main stem; 2.96, 4 UNTs	0.98 main stem; 0.93, one UNT	Flow alterations and siltation from AG
5-Qureg Run & 4 UNTs	09828	3.33	5.75		
3-Indiantown Run	09800	11.6	5.30 main stem; 8.89, 12 UNTs	1.55 main stem; 1.24, 2 UNTs	Siltation from Road runoff
4-Vesle Run	09803	2.28	0.62 main stem; 0.56, one UNT	1.26 main stem; 1.24, 2 UNTs	Siltation from Road runoff
3-**Quittaphilla Creek**	09691	77.3		16.77, main stem; 17.26, 19 UNTs TMDL	Flow alterations, siltation from AG and URB; Bank modifications & other habitat alterations
4-Brandywine Creek	09734	3.46		2.12 main stem; 3.15, 3 UNTs	Flow alterations from URB
4-Snitz Creek	09729	12.4		6.59 main stem; 4.98, 4 UNTs TMDL	Nutrients & siltation from crop related AG
4-Beck Creek	09728	8.13		7.14 TMDL	Nutrients from AG
4-Bachman Run	09724	7.72	0.64 main stem	4.87 main stem; 1.94, 2 UNTs TMDL	Nutrients & siltation from Crop related AG
4-Killinger Creek	09705	15.0		6.53 main stem; 4.67, 8 UNTs TMDL	Nutrients, flow alterations, siltation from AG

5-Gingrich Run	09710	6.01		4.09 main stem; 1.78, 2 UNTs TMDL	Suspended solids, organic enrichment/low DO, flow alterations from AG & URB
6-Buckholder Run	09711	0.91		1.69	Flow alterations, siltation from AG
3-Bow Creek	09635	9.46	7.06 main stem; 14.66, 30 UNTs	0.2 main stem; 0.91, one UNT	Siltation from Road runoff Priority organics
3-**Manada Creek**	09546	32.2	15.5 main stem; 41.23, 62 UNTs	1.39 main stem; 1.73, 3 UNTs. 0.7, one UNT	Siltation from Road runoff Excessive algal growth & nutrients from MUNI
4-Walnut Run & 10 UNTs	09589	3.64	8.72		
3-Spring Creek	09507	24.0	0.35 main stem; 2.0, 4 UNTs	7.75 main stem; 30.52, 10 UNTs	Suspended solids from URB; Siltation from AG; Water/flow variability from Natural causes
3-Kellock Run & 11 UNTs	09479	4.37	10.04		
3-Beaver Creek	09401	27.2	11.76 main stem; 41.02, 60 UNTs	3.63, 10 UNTs; 1.38, one UNT	Flow alterations from URB Flow alteration, siltation from AG
3-Iron Run	09366	7.61	2.94 main stem; 6.59, 6 UNTs	2.53 main stem; 0.77, one UNT	Siltation from AG

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. Susquehanna River=1.

UNTs= Unnamed tributaries, URB=Urban runoff/storm sewers; AG=agriculture; AMD=abandoned mine drainage, MUNI=municipal point source, IND=Industrial point source

Upper Swatara Creek Restoration Plan Summary

Adapted from the 2000 Restoration Plan by Dan Koury, DEP Pottsville District Mining Office

Introduction

The Department of Environmental Protection District Mining Offices started the Comprehensive Mine Reclamation Strategy (CMRS) Program in 1994 through funding from the EPA 104(b)(3) program. Each of the five district mining office selected at least one watershed to study the effects of abandoned mine drainage (AMD) and to develop a strategy for improving the water quality through remining, land reclamation, and installing passive treatment systems. Local citizens and industry were to become involved by encouraging them to take charge of restoration efforts in their watershed.

The Pottsville District Office (DMO) selected the upper Swatara Creek watershed north of the village of Ravine as their primary CMRS watershed. Most of the upper Swatara Creek watershed is undeveloped, with 81% of the land area forested. Mining, primarily abandoned surface mines account for 18%; the remaining 2 % is urban or other uses. None of the area is used for agricultural purposes. No major development changes or industrialization have occurred in the watershed during the past 15 to 20 years. Abandoned coal mine discharges are the principal pollution source in this area of the watershed and have heavily degraded much of the upper watershed.

The upper Swatara Creek watershed was divided into five subwatersheds for CMRS study: Upper Swatara Creek, Good Spring Creek, Middle Creek, Lower Rausch Creek, and Lorberry Creek. Each of these subwatersheds is impacted by AMD to varying degrees.

Land Use in Upper Swatara Creek Watershed					
Watershed Location	**Subwatershed**	**Watershed** Acres	**Forest** Acres	Surface Mine Acres	**Urban** Acres
SWAT 101	Good Spring & Middle Creeks	9,454	6,484	2,650	320
SWAT 02	Upper Swatara Creek	6,226	5,291	935	Negligible
SWAT 03*	Swatara Creek at Lorberry Junction	21,666	17,761	3,585	320
SWAT 22	Lower Rausch Creek	3,021	2,144 68	877	None
L-2	Lorberry Creek	2,709	2,250	459	Negligible
**** Total**		**27,396**	**22,155**	**4,921**	**320**

Abandoned mine drainage from the headwaters of Swatara Creek has also had a significant impact on the downstream watershed. Over 30 years ago, Pennsylvania proposed to construct a 750-acre reservoir on Swatara Creek within a new State Park at Swatara Gap, 15 miles downstream of Ravine. Dam construction was delayed primarily due to poor water quality coming from the headwaters. Water quality has improved greatly over the past 5 years due to remediation projects, enforcement of regulations, mine reclamation, sewage treatment in several communities, and ongoing remediation efforts with passive treatment systems. Building of the dam was reconsidered; however, the U.S. Fish and Wildlife Service identified numerous significant wetlands that would be impacted by the dam and the dam project was withdrawn.

The primary goal of reclamation during the early years was to improve the water quality of Swatara Creek to meet acceptable standards so that the lake could be built. With the recent water quality and biological improvements and the involvement of the local communities, the goal now is to restore the headwaters to a viable fishery. The PA Fish and Boat Commission indicated that the water quality necessary to establish a healthy ecosystem would be pH 6.0 to 6.5, alkalinity greater than acidity by 20 mg/l, iron less than 0.5 mg/l, and aluminum less than 0.5 mg/l.

Resources to abate pollution sources in the watershed were limited in the past. In the 1970's, the DEP Bureau of Abandoned Mine Reclamation (BAMR) restored and redirected stream channels, as recommended in the Operation Scarlift studies. The only other resources available for pollution abatement were reclamation-in-lieu-of-civil-penalties and cooperation from the mining industry through remining. U.S. EPA and Pennsylvania Growing Greener grants have recently become available to fund assessments and demonstrations of passive treatment technologies. The increase in awareness of mine drainage treatment technologies and new sources of funding has accelerated the efforts for improving water quality in Swatara Creek. Several passive treatment systems have been installed since 1995. DEP BAMR plans major restoration projects for the watershed through 2002 that should improve water quality in many of tributaries.

Previous Investigations

- Water Quality Investigations to Determine Feasibility of a Recreational Reservoir on Swatara Creek at Swatara Gap, 1965, Roy F. Weston, Inc.
- Operation Scarlift Reports (Swatara Creek Mine Drainage Abatement Project)
  - Part 1, Project SL-126-1, 1972, Gannett Flemming, Corddry & Carpenter, Inc.
  - Part 2, Project SL-126-2, 1972, Berger Associates, Inc.
  - Part 3, Project SL-126-3, 1972, Anthracite Research & Development Co., Inc.
- Water-Resources Report 85-4023, Results of a Pre-impoundment Water Quality Study of Swatara Creek, PA, 1986, U.S. Geological Survey
- A Watershed Pollution Study of the Swatara Creek, 1987, Skelly and Loy Engineers- Consultants.
- Additional investigations and studies were conducted by DEP in the 1990's. The Pottsville District Mining Office conducted a water sampling study from January through May 1990 to specifically identify the pollution sources and to determine the impacts attributable to the active mining industry.
- A 9-month follow-up study was conducted by DER Bureau of Water Quality Management with assistance from the Pottsville DMO, BAMR, Bureau of State Parks from 1992-93 to assess the water quality for the Swatara State Park Lake project and to further pinpoint pollution problem areas. BAMR established continuous flow recorders on Rowe Tunnel and Tracy Airhole which are still in operation.
- DEP collected annual aquatic and benthic macroinvertebrate data at various locations in the watershed for several years starting in 1993.
- Limestone Treatment of Acidic Mine Drainage in Headwaters of Swatara Creek, Schuylkill County, Pennsylvania, U.S. Geological Survey, began in 1996 to evaluate the effectiveness of 3 projects which use limestone for mine drainage treatment. Monitoring stations were also installed in Ravine and Pine Grove to measure the cumulative effects of the treatment systems throughout the watershed.
- U.S. EPA Section 319 National Monitoring Program, Evaluation of Passive Treatment of Acidic Mine Drainage in Headwaters of Swatara Creek, Schuylkill County, Pennsylvania. This project was the first National Monitoring Project to focus on abandoned mine drainage problems. Water quality data has been collected by U.S. Geological Survey (USGS); the project will continue through 2007. The Ravine location on Swatara Creek and one on the Good Spring Creek tributary are the featured monitoring points.
- Monitoring is ongoing by DEP Pottsville DMO and Office of Surface Mining (OSM) at several key locations to focus on areas where abatement is needed or recently completed.

Current Mining and Potential for Future Mining
In 1971, the U.S. Bureau of Mines indicated that the abandonment of mines in the Southern Anthracite Field resulted in the flooding of 34 percent of the field and that the largest tonnage of anthracite reserves lie where mining conditions are the most difficult. Large reserves that underlie the abandoned workings must be dewatered before they can be mined. Some of these reserves may be "lost" to future mining since the adjacent mine pools, in many cases, must also be dewatered due to the unknown stability and effectiveness of the barrier pillars separating the mine pools. Future mining will be governed mostly by economics and safety.

New markets for the coal refuse have been developed in recent years for the production of electricity and the manufacture of titanium. Since the mid-1980s the enormous abandoned culm piles that were once considered waste, became a marketable material. The market for coal refuse reuse has played a beneficial role in the watershed. Extensive coal refuse piles remaining throughout the upper watershed continue to produce acid mine drainage. Reclamation and use of these piles should continue. Most of the largest culm piles in the watershed have been permitted for at least partially remined.

Forty-eight anthracite permitted mining operations were located in the upper Swatara Creek watershed in 2000; 29 of these were considered active operations; the others were either inactive or not started. The active operations included 12 underground mines, 8 surface mines, 8 coal refuse reprocessesing operations, and 2 coal preparation areas.

AMD Impacts and Restoration Activities
Lorberry Creek:
The 3.99-square mile Lorberry Creek originates as a discharge from the abandoned Lincoln Colliery workings at the Rowe Tunnel then flows southeast to its confluence with Lower Rausch Creek. The Rowe Tunnel is a gravity discharge of extensive interconnected underground mines that contributes the majority of flow, acid and iron, and other pollutants to Lorberry Creek. An estimated 460 acres of unreclaimed surface mines in the headwaters area of Lorberry Creek also contribute to the Rowe Tunnel discharge.

Prior to 1992, slugs of coal sediment, believed to be from active deep mine operations washing their coal underground, also discharged from the Rowe Tunnel. Sediment pollution from the Rowe Tunnel was greatly reduced after these practices were halted. A continuous flow recorder was placed on the discharge in 1992 and monthly water quality samples have been collected since that time by DEP.

The Rowe Tunnel masks the effects of several smaller mine discharges and tributaries that enter Lorberry Creek. The U.S. Geological Survey, U.S. Department of Energy, DEP Pottsville DMO, and the Schuylkill County Conservation District conducted a detailed analysis of the Rowe Tunnel discharge through a FY 1998 U.S. EPA Section 319 grant. They are designing a treatment system that will likely use a combination of aeration, filtration, and alkaline addition.

Stumps Run enters Lorberry Creek 0.2 mile downstream of Rowe Tunnel. Historically, Stumps Run was the major source of coal sediment pollution to Lorberry Creek and Swatara Creek, particularly during storm events. The sediment came from 24.4 acres of abandoned coal siltation basins that were once part of the Lincoln Colliery complex. Stumps Run flowed through the complex where it became ladened with coal sediment. Due to the size of the pollution source and the cost of reclamation, the area was broken down into three reclamation project areas. Three Reclamation-in-Lieu-of-Civil-Penalty projects completed in 1994, 1995 and 1996 reclaimed the land surface and Stumps Run is no longer a major source of pollution. Further enhancements may be needed in the future to insure that erosion and sedimentation controls are maintained. Employees of the Pottsville District Mining Office have planted trees and wetland vegetation on the project sites as an Earth Day project.

A discharge from Shadle Coal Company deep mine flows along Molleystown Road. The mine is sealed and partially reclaimed. The USGS & U.S. Department of Energy (DOE) conducted experiments on treatment options. The Pottsville DMO is reviewing treatment options.

Lower Rausch Creek:
The 4.86-square mile Lower Rausch Creek watershed originates from abandoned surface mine pits north of the juncture of I-81 and PA Route 209 (I-81 Exit 33). The creek flows south along I-81 and in the median between the north and southbound lanes and joins Lorberry Creek just below I-81, Exit 32 (Lorberry Junction). The source of Lower Rausch Creek is near the Westwood Energy complex, a power generating plant constructed in 1986 that uses coal refuse from nearby culm piles and coal siltation basins as fuel. Some surface affected areas have been reclaimed with the flyash residual produced during power generation.

Lower Rausch Creek encounters several abandoned deep mine discharges along its path. Prior to 1991, it flowed through siltation basins and carried a large coal sediment load particularly during storm events. Westwood Energy diverted Lower Rausch Creek around the siltation basins and established a rock-lined channel to prevent sediment pollution. Since the diversion, high sediment loads have not been recorded in Lower Rausch Creek and iron has been identified as the major pollutant.

In 1995, USGS installed an experimental Anoxic/Oxic Drain treatment system on the South Orchard Drift discharge using US EPA 319 funds. The research data from this system was useful in the design of an anoxic drain on a headwaters discharge to Swatara Creek.

A 2.3-acre wetland/impoundment was created in late 1997 on Lower Rausch Creek just upstream of its confluence with Lorberry and Swatara Creeks, within the I-81, Exit 32 interchange. DEP BAMR constructed the wetlands with partial funding under a US EPA 104(b)(3) grant. The wetland was designed to abate iron and other metals of the stream as a whole, rather than treating discharges individually.

Good Spring Creek:
The 14.8-square mile Good Spring Creek watershed originates ½ mile southeast of the village of Good Spring. The stream flows from abandoned strip mines in a northeasterly direction towards I-81 and then easterly to the village of Donaldson and south through the Borough of Tremont where it joins Middle Creek. An estimated 2,650 acres of unreclaimed surface mines and coal reprocessing operations are located in the Good Spring and Middle Creek watersheds. Numerous culm piles contribute sediment and acid during storm events. These abandoned sites are potential sites for remining.

Good Spring Creek has also been polluted with sewage from the village of Donaldson and Tremont Borough. Although Tremont has had sewage treatment since the early 1980s, improvements were not seen in Good Spring Creek until 1993, after Donaldson was connected to the Tremont sewer system. AMD from abandoned deep mines is now the major pollutant.

The most significant source of pollution to Good Spring Creek is the Tracy Airhole discharge, an abandoned deep mine airway that serves as the main drainage point for the Good Spring #3 mine pool. The Tracy Airhole is the most significant source of iron pollution in the entire Swatara Creek watershed and masks the effects of other discharges to Good Spring Creek. The average flow from the airway exceeds 1500 gpm and the average iron concentration is 18.3 mg/l. The discharge has been monitored extensively during the past 3 decades. A continuous flow monitor has been in place since 1992 and monthly grab water samples have also been collected. The discharge has improved slightly over recent years; however, it still has a significant impact on the watershed. The main treatment option being considered is diversion of the discharge to the nearby DEP BAMR operated Rausch Creek Treatment Plant. An agreement between DEP and Harriman Coal Corp. had been developed to breach the barrier pillar separating the Good Spring #3 mine pool to Swatara Creek and the Good Spring #1 mine pool to Rausch Creek, thus dewatering the Good Spring #3 mine pool and eliminating the Tracy Airhole discharge from the Swatara watershed all together. If the diversion does not take place, other treatment options will be developed.

Martin Run originates on the south slope of Broad Mountain due north of Donaldson. Martin Run receives the Eureka Tunnel discharge and continues flowing south approximately 2,000 feet to the Colket mine pool discharge. Martin Run then continues south under PA Route 125 and joins Good Spring Creek in the village of Donaldson. The Eureka Tunnel continues to discharge despite being sealed in the early 1990's. A significant amount of iron precipitate, in excess of 6 feet deep at the tunnel exit makes the discharge flow nearly impossible to accurately measure. The discharge braids and joins Martin Run at several points. Treatment at the discharge was not feasible due to the lack of sufficient space; therefore, a diversion well was installed on Martin Run in July 1996. Funding was through an U.S. EPA 319 grant. The purpose of the diversion well is to add limestone, increase alkalinity, and accelerate the precipitation of metals, thereby improving the water quality of Good Spring Creek. No room was available for ponds below the diversion to allow settling of metals. Martin Run joins Good Spring Creek approximately 200 feet south of the diversion well. The diversion wells have increased the pH and alkalinity in Martin Run; however, the overall improvements are difficult to determine since the metals precipitate in the stream channel. A more positive improvement has been noted several hundred feet downstream in Good Spring Creek.

Several Operation Scarlift Projects just north of the Colket discharge reclaimed abandoned surface mine pits and restored Martin Run to its original channel. Prior to the reclamation, Martin Run was bisected by a surface mine pit and water was conveyed via underground workings to the Coal Run mine pool. DEP BAMR is planning a 3-phased project to reclaim an additional 120 acres of abandoned surface mines along the contour of the mountain north and west of the Colket discharge. Reclamation will decrease the amount of water infiltration into the mine pool. A passive treatment system is also being developed by BAMR to treat the Colket discharge.

Abandoned surface mines along the contour of Broad Mountain intercept streams and runoff from the mountain and divert water into the deep mines. An unnamed tributary that once flowed south on Broad Mountain into surface mine pit was restored to surface flow in September 1998 using U.S. EPA 104(b)(3) funds. The restoration prevents water from entering the mine pool and helps dilute iron pollution from the Tracy Airhole.

The John Behm Tunnel (Bowmen & Coleman Tunnel) discharge ½ mile west of Donaldson was sealed in the early 1990s but continues to drain mildly acidic and an average of 5.0 mg/l iron. An abatement strategy is being developed to improve the quality of the discharge.

<u>Middle Creek</u>:
Middle Creek originates on the Broad Mountain north and east of Donaldson and flows south to Tremont where it is joined by Good Spring Creek. This 8.5-square mile watershed includes the tributaries Coal Run, Gebhard Run, and Bailey Run. Extensive surface and underground mining relocated many of these streams or diverted them into open surface mines and into underground workings. Concrete flume diversions, streambed restoration, and reclamation of surface and deep mines were completed on Gebhard Run, Middle Creek, Coal Run, and Bailey Run in the 1960s and 1970s. This watershed no longer contributes to the acid loading to Swatara Creek.

A large surface mine pit on the Mammoth Coal Vein once bisected Middle Creek. The water resurfaced 150 feet north of T-571 at the Clinton #1 discharge (Middle Creek Discharge). Backfilling of the Mammoth Pit and restoration of Middle Creek to the surface by BAMR in 1999 resulted in a reduction of water to the Middle Creek mine pool. Remaining flow from the Clinton #1 discharge will be addressed with a passive treatment system developed by BAMR.

DEP has been monitoring other discharges from the Middle Creek mine pool west of the Clinton #1 discharge since 1995 at a sampling point referred to as Coal Run, which is actually a combination of two drainage outflows of the Middle Creek mine pool, the Tracy Outflow and the Clinton #2 discharge. Past studies ranked these discharges as the major contributors of acid to Middle Creek and Good Spring Creek. Operation Scarlift surface reclamation projects completed on Martin Run during the 1970s improved discharge water quality and reduced the flow. Recent data shows marginally good water quality with an average pH of 6.0 and iron and manganese of less than 2.0 ppm. These discharges may further decrease in flow after the surface flow restoration of Middle Creek. Any remaining flow from the Clinton #2 discharge and the Tracy Overflow will be addressed with a passive treatment system developed by BAMR.

Two discharges from the Indian Head mine pool called the Marshfield #1 and #2 discharges enter Coal Run a few hundred feet below T-571. The Indian Head mine pool underlies large coal silt dams and culm piles associated with the abandoned Indian Head Colliery. Weirs were installed on the 2 discharges in the September 1998 with the use of EPA 104(b)(3) funds to facilitate collection of chemical and flow data necessary develop a passive treatment system.

Opportunities for further improvements by remining exist throughout the Middle Creek watershed. Some of the large silt and culm piles, particularly in the Indian Head area are currently permitted and may be removed.

Upper Swatara Creek:
The upper Swatara Creek watershed includes the 10-square mile portion of Swatara Creek upstream of the mouth of Middle Creek. Swatara Creek originates near I-81 east of Exit 34 (Hegins) as runoff from abandoned surface mine pits and flows south-southeast where it encounters abandoned deep mine discharges, the Commonwealth Environmental Services Landfill, the inactive John Fry Landfill, active and abandoned mining operations, a waterfall, and several recently constructed treatment systems. Swatara Creek is joined by Pollys Run south of U.S. Route 209, and proceeds west through a valley on the north side of Sharp Mountain known as Blackwood where it is joined by Panther Creek, and continues past the Tremont Sewage Treatment Plant where it is joined by Middle Creek.

A 1993 DEP study identified an unnamed abandoned drift mine discharge called Hegins Run that enters Swatara Creek one mile north of U.S. 209 as a significant source of aluminum pollution to the upper watershed. The discharge has pH of 3.2 and an aluminum concentration in excess of 5.0 ppm. Since access to the discharge is difficult, a system on Swatara Creek was considered the best option for treatment. Two diversion wells were constructed in 1995 on Swatara Creek along the north side of U.S. 209, downstream of the Hegins Run discharge through a partnership between DEP Pottsville District Mining Operations, Schuylkill County Conservation District, industry and local citizens. A local businessman provided the funding. A continuous data recorder was established upstream and downstream of the diversion wells in 1996 to monitor success of the wells.

In 1997, an anoxic limestone drain (ALD) and an open limestone channel were installed upstream of the Swatara Creek diversion wells with U.S. EPA 319 funds. Installation of these treatment systems at different times allowed the effectiveness of the individual treatment systems to be evaluated. A joint study by the USGS and DEP funded by EPA 104(b)(3) determined that the ALD was the most effective and maintenance free treatment system. The results were detailed in several reports and presentations by USGS at mine drainage reclamation conferences.

The Blackwood Tunnel, Panther Creek, and numerous other small discharges do not appear to have a negative impact on the quality of Swatara Creek; however, this area needs further study. Several BAMR reclamation projects are designed for the Blackwood area. A surface mine permit operation is removing culm piles and silt dams from the abandoned Blackwood Breaker and remining some of abandoned pits. Future remining and reclamation permit operations will help minimize the potential for AMD pollution.

Restoration Projects

Operation Scarlift Projects:

The 1972 Operation Scarlift Investigation Reports recommended a variety of AMD abatement projects in the watershed at an estimated cost exceeding $33 million s. Twelve abatement projects, mostly in the Middle Creek and Good Spring Creek watersheds, were constructed in the 1970s at a cost of slightly over 3 million dollars. One additional reclamation project, the Lorberry Junction Project in the headwaters of Lower Rausch Creek, was completed in the early 1990's with $322,795 from the Abandoned Mine Lands (AML) Fund.

Most of the Operation Scarlift abatement work consisted of restoration of stream channels, installation of concrete flumes to keep streams from loosing water to deep mines, diversion of polluted waters away coal refuse materials, and land reclamation. Several of the diversion ditches and in-ground flumes are still in good condition today. Regrading and vegetation also limited the amount of surface runoff and surface water infiltration to the deep mine groundwater pools.

Operation Scarlift Abatement Projects

SL-Project I.D. Number	Abatement Description
SL-126-2-9	Rechannelization of Martin Run, regrading and revegetation of approximately 200 ft. (61 m) buffer zone from centerline of the stream, 1975
SL-126-2-7	Regrading and vegetation of western portion of Area 1. Diversion ditches constructed around perimeter of abatement area. Flumes constructed within the existing channel of Baily's Run, 1973-77
SL-126-2-1	Installation of flume on Coal Run, drainage ditches, reconditioning of stream beds, 1970
SL-126-2-7	Area west of the existing flume of Coal Run construction: diversion ditches along northern perimeter of site and regrading and revegetation of the entire area. Several fiber flumes constructed to control east-west drainage within the surface mined areas, 1973-77
SL- 126-2-7	Regrading and vegetation of eastern portion of Area 1 west of Martin Run, 1973-77
SL-126-2-2 .	Installation of flumes, construction of drainage ditches and reconditioning of streambeds, 1970
SL-126-2-7	Eastern portion of Area 2, a 1,637-foot fiber flume, draining Gebhard Run just below existing flume at headwaters, 1973-77
SL-126-2-7	Western portion of Area 2: installation of 1,060 ft. (323 km) fiber flume across the central portion of the site running east-west; regrading and vegetation, 1973-77
SL-126-2-7	Regrading and revegetation, 1973-77
SL-126-2-7	All work within this area was terminated at landowners request following initial regrading. No revegetation work completed under, 1973-77

SL-126-2-7	Rechannelization of Middle Creek, 1973-77
SL-126-2-6	Acid mine drainage abatement on Gehard Run, 1973-78
SL-126-2-7	Relocation of Gebhard Run, 1973-77
SL-126-2-7	Relocation of Gebhard Run, 1973-77
SL-126-1-5	Grading andvegetation; construction of the Primrose vein channel, 1977
SL-126-1-5	Grading, vegetation, and channel reconstruction, 1977
SL-126-1-5	Closing of two shafts, stream channelization, regrading, and vegetation of the area, 1977
SL-126-1-5	Regrading and revegetation, 1977
	Rechannelization of Swatara Creek and grading along rechannelized streambed.

Restoration Projects Completed Since 1990:
All of the following projects, with the exception of Project 5, directly impact AMD discharges or streams. Many of the improvements in the water quality and the aquatic communities are the result of the cumulative positive effects of the various projects.

- PROJECT 1 (1991) Relocation of Lower Rausch Creek. Westwood Energy, Inc. redirected Lower Rausch Creek around the large silt dams on their property, thus eliminating large quantities of coal silt from washing into the creek during storm events and snowmelt.
- PROJECT 2a (1994) Stumps Run Reclamation Project #1. Reclamation of the largest source of coal sediment pollution in the Swatara Creek watershed. Stumps Run, a tributary of Lorberry Creek, meandered through abandoned coal siltation basins from the abandoned Lincoln Colliery. During storm events and snowmelt, the stream flowed black with coal sediment exceeding concentrations of 1615 ppm. The area was broken down into 3 projects because of the large area in need of reclamation and lack of funding. This portion addressed the major pollution source. Lehigh Coal & Navigation regraded and removed silt, vegetated, and installed erosion and sedimentation controls on 12.2 acres in lieu of $40,000 in fines. Suspended solids have not exceeded 20 ppm since completion of this project.
- PROJECT 2b (1995) Stumps Run Reclamation Project #2. A Harriman Coal Corporation reclamation-in-lieu of $41,175 in fines project at an abandoned siltation basin with a high sediment discharge adjacent to Project #1. The site drained to Lorberry Creek upstream of Stumps Run. The operation removed silt, regraded and, revegetated 8.2 acres, and installed erosion and sedimentation controls.
- PROJECT 2c (1996) Stumps Run Reclamation Project #3. This 4.0-acre project was completed by Lehigh Coal & Navigation through a reclamation-in-lieu of penalty fine of $50,000. The site was graded, revegetated, and erosion and sedimentation controls were installed. Additional work was done to improve upon the Project #1 area.
- PROJECT 3 (1995) Anoxic/Oxic Drain. USGS installed an anoxic/oxic drain on the Orchard South Discharge in the Lower Rausch Creek subwatershed as an experiment to monitor the effect of oxygen on the limestone in limestone drain systems. Funded under a U.S. EPA 319 grant.
- PROJECT 4 (1995) Swatara Creek Diversion Wells. Two diversion wells were installed on Swatara Creek, 3 miles downstream of the headwaters to treat inaccessible upstream discharges. Several unique modifications were installed for easier maintenance. A local businessman funded the project in honor of his father, an avid fisherman. The project has involved businesses, state, federal and local agencies, and over 50 citizens of the local community and sparked the formation of the Northern Swatara Creek Watershed Association.
- PROJECT 5 (1995) OSM54(2011)101.1 Lorberry Junction Reclamation, consisted of backfilling of several abandoned strip mine pits near the headwaters of Lower Rausch Creek. This was a DEP BAMR land reclamation project with no AMD treatment. Costs were $322,795 in AML funds.

- PROJECT 6 (1996) Diversion Well on Martin Run in the Village of Donaldson on the north side of Route 125. The well was installed to abate discharges from the Colket mine pool and the Eureka Tunnel. The topography of the site did not allow for cost effective treatment at the pollution sources. The well increases the pH 1 to 1.5 pH units; however, metals precipitate in the stream channel. The work was completed with U.S. EPA 319 funds and volunteer efforts from local citizens and the PA National Guard.
- PROJECTS 4, 7, 8 (1996) Study of treatment systems and current water quality of Swatara Creek. A cooperative effort between the USGS and DEP to evaluate the effectiveness of individual limestone treatment systems installed and their cumulative effects on Swatara Creek. Four continuous water quality monitoring stations were installed with U.S. EPA 104(b)(3) grant for 1996, 97, 98 and continued under the US EPA 319 National Monitoring Program and other funding sources.
- PROJECT 7 (1997) Limestone Channel on Swatara Creek. A limestone channel was constructed upstream of the discharge known as Hegins Run to increase the pH of Swatara Creek upstream of the diversion wells. Funded by a US EPA 319 grant.
- PROJECT 8 (1997) Anoxic Limestone Drain. An anoxic limestone drain was constructed on an unnamed abandoned mine drainage discharge at the headwaters of Swatara Creek (pH 4.0, iron 9.0 mg/l), with US EPA 319 funds, donated assistance, and materials from an adjacent landfill. The project was designed by USGS and contains several testing features to allow monitoring and maintenance.
- PROJECT 9 (1997) Pollys Run Project. Streambank stabilization and rechanneling of Swatara Creek 0.25 miles downstream of the Swatara Creek diversion wells, near the Swatara Coal Co. During heavy flooding in January 1996, Swatara Creek washed away large quantities of coal silt from a portion of the streambank and deposited it in a downstream wetland area. The creek braided and a portion pooled and leached heavy metals as it seeped through coal silt into a canal that drains to Pollys Run. The project included a 700-foot limestone riprap channel to redirect and stabilize Swatara Creek and revegetation. The project prevents the possibility of a future sedimentation event and prevents water from Swatara Creek from entering the canal. Funded by a U.S. EPA 319 grant.
- PROJECT 10 (1997) Lorberry Junction Wetland Project. Two shallow water aerobic wetland impoundments were constructed in the interchange of I-81, Exit 32, Ravine (also known as Lorberry Junction) to treat of several abandoned mine discharges on Lower Rausch Creek. The wetlands remove metals from all of the discharges collectively from Lower Rausch Creek. Funded by a U.S. EPA 104 (b)(3) grant and with fines assessed against Pine Grove Landfill by DEP Bureau of Waste Management. Designed by DEP Bureau of Mining and Reclamation and constructed by DEP Bureau of Abandoned Mine Reclamation. Additional materials and equipment were donated by local industries. This visible site also serves as a public educational area.
- PROJECT 11 (1998) Development of treatment for Rowe Tunnel discharge. A cooperative effort between the U.S. Department of Energy (DOE), USGS, DEP, and Schuylkill County Conservation District. Treating the discharge will require pH adjustment, aeration, filtration, or a combination of these methods. A detailed characterization of the water was conducted to determine the most effective treatment method. Two diversion wells were installed on the Rowe Tunnel discharge in November 1998 as part of a prototype system. Funded by a US EPA 319 grant and matching funds from USGS and DOE.
- PROJECT 12 (1998) Swatara Creek EPA 319 National Monitoring Program Project, the first National Monitoring Project in the country that focused on mine drainage and treatment practices. The evaluation of the cumulative effects of various treatments will be useful in developing a treatment strategy for other discharges in the Anthracite Region.
- PROJECT 13 (1998) Reconstruction of a Stream Channel near the John Behm Tunnel. A 360-foot limestone channel was constructed to convey an unnamed spring fed stream that previously flowed into an abandoned surface mine pit. The stream now flows into Good Spring Creek and reduces the volume of water entering the mine pool system. Funded by US EPA 104(b)(3).

- PROJECT 14 (2000) Hegins Run Oxic Limestone Channel Project. A 190-foot long oxic limestone channel was constructed on the Hegins Run discharge, an abandoned drift mine to Swatara Creek. The channel consists of over 800 tons of limestone and was constructed in 4 cells to maximize retention time. This project targeted one of the main sources of pollution mentioned under Project 4. Funded by a Watershed Restoration and Protection Act (WRAP) grant.
- 1998 Assessment of 5 discharges. Weirs were installed on the Tracy Outflow, Clinton #1, Clinton #2, Marshfield #1, and the Marshfield #2 in the Middle Creek watershed to determine proper remediation systems. Funded under the BAMR Ten Percent Set Aside program.

Results of Reclamation and Remediation Projects
The USGS continuous flow monitoring gage at Ravine (SWAT 19) is the focal point to determine the overall impacts of AMD on the water quality of Swatara Creek. Additional sampling stations at Swatara Creek (SWAT 03), Lorberry Creek (LR-2), and Lower Rausch Creek (SWAT 17) prior to their confluence, indicate an increase in pH and a decrease in acid, sulfates, and metals associated with AMD. In recent years one of the greatest positive impacts on the aquatic life in the watershed has been the minimized pollution slugs during storm events. Although the water quality has improved in many areas throughout the watershed, many of the discharges and streams are still polluted by AMD.

Specific improvements noted:

- Reclamation of abandoned mine areas through reclamation-in-lieu of civil penalties and installation of passive treatment systems, such as diversion wells, anoxic drains, open limestone channels and constructed wetlands during the past 5 years have improved water quality significantly in Swatara Creek watershed.
- The passive treatment systems are effective when properly maintained. Maintenance problems and sizing constraints limit use of these systems in some portions of the watershed.
- The main sources of coal sediment pollution or black water were reclaimed from 1994 to 1996; however, potential sediment pollution still exists because of the numerous remaining abandoned coal silt dams and culm piles.
- Chemical data collected at the lower end of the mined area at Ravine shows that the water quality of Swatara Creek continues to improve; however, Swatara Creek is still degraded by AMD and iron precipitate orange staining (yellow boy) still coats the stream bottom.
- Extreme water quality fluctuations have been reduced significantly. Swatara Creek maintains a fairly constant pH even during storm events.
- Data collected during storm events shows that precipitated metals are scoured during rapid increases in stream flow. The metals are not likely to redissolve further downstream.
- The aquatic life of Swatara Creek and its tributaries are also recovering. All of the major tributaries in the watershed now have some aquatic life. The diversity and quantity of benthic macroinvertebrates and fish species have increased dramatically over the past 10 years. Fish and macroinvertebrates are present in streams that have not had aquatic life for many years.

Water Quality Data

Water Quality of Upper Swatara Creek s							
Location	**Date**	**pH min-max median**	**Fe (mg/l) min-max median**	**SO_4 (mg/l) min-max median**	**Acid (mg/l) min-max median**	**Acid load (lbs/day) min-max median**	**Flow (gpm) min-max median**

SWAT 03 Swatara Above Lower Rausch Creek	1971-72	3.2 - 4.5 4.0 avg	0.5 - 4.6 1.4 avg	55 - 240 124 avg	18 - 72 35 avg	3,788 – 13,678 8,324 avg	4,797 - 112,638 19,699 avg
	1985-86	4.4 - 5.9 5.1	0.12 – 4.8 1.5	50 - 160 106	4 - 37 6	273 - 7,672 1,560	3,384 – 106,651 15,502
	1992-93	5.1 – 6.8 6.0	0.15 – 4.7 1.1	36 - 152 79	0 - 14 8	0 – 7,188 3,537	5,135 - 85,636 32,316
L-2 Lorberry Creek at mouth	1971-72	4.0 - 6.3 5.2 avg	5.0 – 15.6 9.7 avg	60 - 120 80 avg	17 - 44 27 avg	681 - 1,763 1,746 avg	1,058 - 25,163 5,336 avg
	1985-86	3.3 - 5.4 4.1	3.5 – 26.2 6.4	51 - 232 97	6 - 167 14	133 - 3,415 562	834 - 9,740 2,601
	1996-97	5.0 - 6.0 5.8	2.3 – 31.0 4.2	41 - 100 68	8 - 14 11	214 – 2,001 725	1,620 - 13,913 4,5334
SWAT 17 Lower Rausch Creek above Lorberry Creek	1971-72	4.2 - 6.6 5.9 avg	3.4 – 20.5 8.8 avg	65 - 320 159 avg	10 - 49 26 avg	691 - 2,749 1,216 avg	751 - 19,165 3,914 avg
	1985-86	4.6 - 7.3 6.6	4.4 - 8.5 5.6	98 -215 165	2 - 25 5	48 – 595 143	566 - 9,695 1,804
	1996-98	5.6 - 6.6 6.3	1.2 - 5.0 2.5	50 - 178 124	0 - 16 2	0 - 1,117 33	581 - 10,582 2,734
SWAT 19 Swatara Creek in Ravine	1985-86	4.5 - 7.2 5.0	0.43 - 4.1 2.5	52 - 156 103	3 - 28 5	329 - 8,571 2,065	6,688 – 142,998 22,322
	1996-97	5.8 - 6.9 6.2	0.46 -120 4.1	24 - 100 64	0 - 8 3	0 - 37,847 2,164	9,798 – 388,432 37,957

Summary of Water Quality from Sampling Points in Upper Swatara Creek

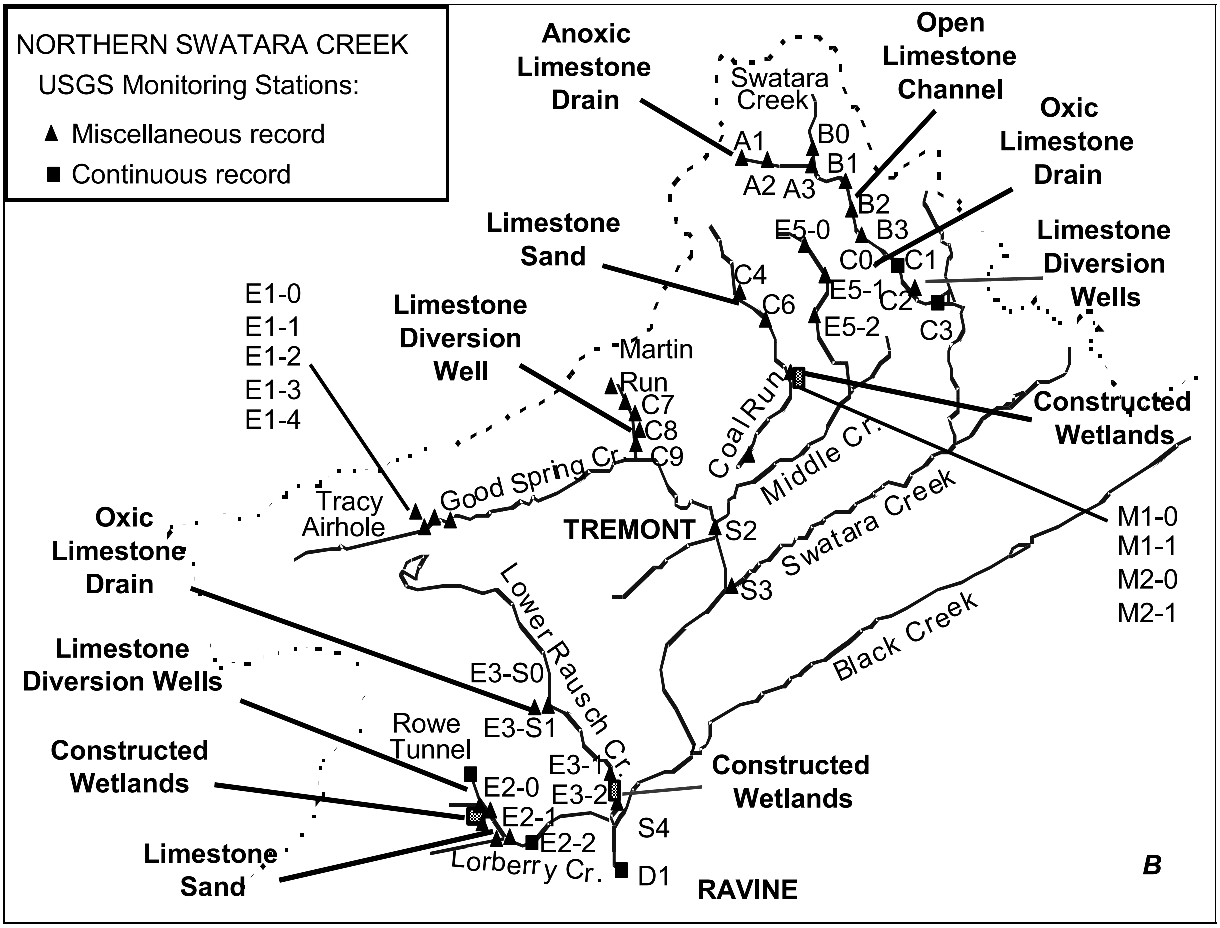
	Monitoring Point	pH Median	Iron (mg/l) median	SO_4 (mg/l) median	Acid (mg/l)	Flow (gpm) median
1	SWAT 04	5.8	8.600	106	18	1771
2	SWAT 11	6.0	0.109	16	3	225
3	L-1	3.3	540.0	1,800	1,196	25
4	SWAT 18	5.3	3.450	89	16	3,523
5	L-2	5.8	4.200	68	11	4,533
6	LR-1	6.3	0.300	55	0	108
7	LR-2	3.7	0.416	52	42	6
8	LR-3	3.5	1.900	225	69	16
9	LR-4	6.2	23.0	378	28	25
1010	LR-5	6.3	9.940	49	0	10
11	SWAT 17	6.3	2.455	124	2	2,733
12	SWAT 22	6.2	2.270	82	1	3,787
13	GS-1	6.3	0.300	40	0	

14	SWAT 01	6.0	18.80	291	5	1,133
15	GS-2	4.8	0.181	20	6	247.5
16	GS-3	6.0	5.310	35	6	30
17	GS-4	4.7	0.888	25	9	832
18	GS-5	6.1	17.050	168	30	
19	GS-6	4.9	2.800	67	14	504
20	GS-7	6.0	2.600	61	7	466
21	SWAT 12	6.3	2.715	97	0	11,400
22	SWAT 13	6.1	2.260	93	10	
23	M-1	6.3	0.382	26	0	81
24	M-2	5.1	0.460	20	7	1,083
25	SWAT 21	5.0	2.330	76	15	1,591
26	M-3	NO DATA AVAILABLE				
27	M-4	5.8	3.050	0	78	653
28	SWAT 20	6.0	1.695	80	4	910
29	M-5	6.5	3.335	101	0	277
30	M-6	6.5	8.700	124	0	293
31	SWAT 101	6.4	1.150	138	1	
32	SW-1	4.5 (6.5)	9.150 (9.350)	45 (42)	28 (0)	166 (60)
33	SW-2	4.3	0.160	13	11	707
34	SW-3	3.6	0.274	159	57	75
3534	SW-4	4.0	0.332	42	22	765
365	SW-5	4.3 (5.15)	0.457 (0.285)	39 (41)	17 (7)	1,058 (878)
37	SWAT 15	6.2	0.395	43	0	1,243
38	SW-6	5.0	1.760	87	16	160
39	SWAT 14	4.2	1.060	88	26	
40	SWAT 16	6.3	0.886	79	0	
410	SW-7	5.9	0.679	108	1	
42	SWAT 02	5.1	0.447	73	10	7,495
43	SWAT 103	6.5	2.010	149	0	
44	SWAT 104	6.4	0.145	11	3	
45	SWAT 03	6.0	1.130	79	8	32,315
46	SWAT 19	6.1	1.200	77	2	26,705

( ) indicates water quality after installation of limestone treatment project.

Biological Investigations:
Biological surveys conducted over the past 10 also indicate that Swatara Creek is a recovering stream. In 1985, no fish were found at SWAT 19 (Ravine); in 1994, six species of fish were found. Both the abundance and number of species fish have increased every year since then

Locations and Types of Treatment Systems and USGS Sampling Stations



Aquatic sampling was conducted by USGS over a 5-year period at four stations in the watershed: (1) Middle Creek at mouth, (2) Swatara Creek above Middle Creek, (3) Lower Rausch Creek at mouth, and (4) Swatara Creek at Ravine. The information collected at these sites is used to determine if the macroinvertebrate community has been affected by AMD, how the community has changed over time, and how the communities differ between sampling stations. Because most of the watershed is AMD impacted, no reference stations were established for macroinvertebrates within the watershed. This monitoring will continue for another 5 years with funding from the US EPA 319 National Monitoring Project (NMP).

A healthy macroinvertebrate community consists of organisms from several insect orders, including ephemeroptera, plecoptera, and trichoptera, diptera, megaloptera, odonata, and coleoptera. Insects from the ephemeroptera (mayflies), plecoptera (stoneflies), and trichoptera (caddisflies), known as the EPT taxa, are considered the most pollution sensitive. Streams that contain a diversity of these organisms are considered healthy, while a stream with few or none of these insects would be considered pollution impacted.

Swatara Creek above Middle Creek has the most insect taxa compared to the other three stations and is the second most diverse station; however, only one mayfly and two stoneflies were collected at this site during the past five years. This lack of stoneflies and mayflies indicates that this station is pollution impacted. The mouth of Middle Creek is also AMD impacted. One mayfly and two stoneflies were collected during the past five years. The greatest number of insects collected was 31 on September 4, 1997. This site had at least 75% fewer insects than Swatara Creek upstream of Middle Creek in 4 out of 5 samples.

The mouth of Lower Rausch Creek is also AMD impacted. This station had the fewest number of individuals and the lowest diversity of the four stations that were sampled. No mayflies and only one stonefly have been collected in the last 5 years. Swatara Creek at Ravine is at the southern edge mined area of the watershed. This station is being used to measure the cumulative impact of treatment systems throughout the headwaters. While some treatment systems have been completed in the watershed and fish populations have shown a substantial increase in numbers and diversity, the macroinvertebrate community is still impacted. No mayflies were collected in 1985, 1994, or 1996. Three mayfly genera were collected in the 1997 sample, indicating an improvement in water quality.

The macroinvertebrate communities at the different sample locations are affected by AMD discharges. While numbers and diversity have remained low over the last five years, a slight trend towards increasing macroinvertebrate numbers has been noted. Installation of additional AMD treatment systems and reclamation of affected land areas should continue the improvement in number and diversity of macroinvertebrates.

Results of Fish Population Surveys on Middle Creek 1996–1999				
Middle Ck (upstream of SWAT 101) near Tremont (behind Behm's Restaurant)				
	Number of each specimen			
Species Name	**7/22/96**	**10/1/97**	**9/28/98**	**9/28/99**
Blacknose dace, *Rhinichthys atratulus*	3	21	23	27
Brook trout, *Salvelinus fontinalis*	11	16	13	12
Brown trout, *Salmo trutta*	3	2	2	1
Chain pickerel, *Esox niger*			1	1
Creek chub, *Semotilus atromaculatus*	13	30	11	17
Cutlips minnow, *Exoflossum maxillingua*				1
Fall fish, *Semolitus corporalis*	10	23	17	75
Golden shiner, *Notemigonus crysoleucas*				1
Margined madtom, *Noturus insignis*				1
Pumpkinseed, *Lepomis gibbosus*		2	2	2
Rainbow trout, *Onorhynchus mykiss*		1		2
Redbreast sunfish, *Lepomis auritus*		1	1	
River chub, *Nocomis micropogon*		1		6
Rock bass, *Ambloplites rupestris*		1		
Smallmouth bass, *Microptreus dolomieui*		1		2
White sucker, *Catostomus Commersoni*	5		4	11
Total	**45**	**99**	**74**	**159**
Number of Species	**6**	**11**	**9**	**14**

Fish Species and Numbers Collected in Swatara Creek at Ravine 1985-1999						
SWAT 19 (Ravine)						
	Number of Individuals					
Species Name	**10/85**	**9/8/94**	**7/23/96**	**10/1/97**	**9/28/98**	**9/28/99**
Blacknose dace, *Rhinichthys atratulus*		1	22	47	162	6

Bluegill, *Lepomis macrochirus*					2	1
Brook trout, *Salvelinus fontinalis*			19	10	21	5
Brown bullhead, *Ameiurus nebulosus*				1	12	2
Brown trout, *Salmo trutta*			2		1	2
Chain pickerel, *Esox niger*						2
Creek chub, *Semotilus atromaculatus*		3		7	22	1
Cutlips minnow, *Exoflossum maxillingua*				1		
Fall fish, *Semolitus corporalis*		15		66	54	30
Golden shiner, *Notemigonus crysoleucas*					1	
Largemouth bass, *Micropterus salmoides*				1		
Longnose dace, *Rhinichthys atratulus*		1	12	1	17	4
Margined madtom, *Noturus insignis*					2	9
Northern hog sucker, *Hypentelium nigricans*						5
Pumpkinseed, *Lepomis gibbosus*				1		2
Redbreast sunfish, *Lepomis auritus*					2	2
River chub, *Nocomis micropogon*		7	1	14	9	44
Rock bass, *Ambloplites rupestris*						6
Rosyface shiner, *Notropis rubellus*				1		
Sculpin, *Cottus sp.*					2	
Shield darter, *Percina peltata*						3
Smallmouth bass, *Micropterus dolomieu*				7		52
Spotfin shiner, *Cyprinella analostana*					3	3
Stoneroller						2
Tessellated darter, *Etheostoma olmstedi*				12	16	3
White sucker, *Catostomus commersoni*		2	20	25	52	22
Yellow bullhead, *Ameiurus natalis*				1	1	
Total Number of Individuals	**0**	**29**	**76**	**195**	**379**	**206**
Number of Species	**0**	**6**	**6**	**15**	**17**	**21**

Future Plans and Needs
Reclamation projects are planned for over the next several years, including some which will directly impact or treat mine drainage and land reclamation which will indirectly impact water quality by preventing surface water from entering the mine pool. Projected costs of all projects exceed $7.5 million. The majority of projects will be designed or lead by the DEP Bureau of Abandoned Mine Reclamation (BAMR). The two most significant sources of pollution in the watershed, Tracy Airhole and Rowe Tunnel, are still untreated. The Tracy Airhole discharge is being studied for treatment through diversion to the Rausch Creek AMD Treatment Plant owned and operated by BAMR. Diversion of the Tracy Airhole to the adjacent Rausch Creek treatment plant would eliminate 1.7 MGD of AMD from entering Good Spring Creek.

The hydrology of the Good Spring and Middle Creek subwatersheds may be altered over the next few years. Stream channel restoration projects alone would prevent 1.9 MGD of water from entering the mine pool and may result in a decrease flow and pollution load from several discharges. Flow would be returned to the surface. The BAMR reclamation projects will also decrease infiltration to the mine pool in the Donaldson, Tremont and Middle Creek areas.

Most of the mine pools are contained to various elevations by a system of barrier pillars. Barrier pillars are sections of coal which were left in place underground to separate colliery workings and their water systems. The mine pool levels are governed by the elevation of points of overflow to the surface or the elevation of breaches in these barrier pillars. The existing condition of these barrier pillars is largely unknown. Breaches may have been created in the pillars by “bootleg” deep mine operations (un-mapped) and/or geologic structural failure.

Nine mine pools in the watershed contain large quantities of water; all are overflowing and discharging mine drainage. The major mine pools are the Blackwood, Colket, Good Spring #3, Indian Head, Lincoln, Middle Creek, New Lincoln, Rausch Creek East Franklin, and Westwood mine pool. It was estimated in Operation Scarlift that four of the mine pools collectively contained in excess of 1.68 billion gallons of water.

Proposed Remediation and Reclamation Projects
Major remediation and reclamation projects are scheduled for the next five years to continue the efforts to improve the water quality of Swatara Creek. Many projects are in the design stage and will be constructed as funding becomes available. Potential funding sources include AML Title IV Grants, Growing Greener, AML 10% Set Aside funds, OSM Clean Stream and Section 319 funding. An estimated total of $8,150,00 will be needed to complete all the proposed projects.

Proposed Projects:
- AML-1 Tracy Airhole Diversion, diversion of the Tracy Airhole (Good Spring #3 mine pool discharge) from the Swatara Creek watershed to the Rausch Creek AMD Treatment Plant. This will be a cooperative effort between DEP and Harriman Coal Corp that will require breaching 2 barrier pillars to drain the mine pool and redirect the discharge to Rausch Creek. Cost estimates have not been secured. This planned project in no longer under consideration due to
- AML-2 OSM 54 (4214) 101.1 Middle Creek, to backfill 58 acres of surface mine pits and reconstruct 1100 linear feet of stream channel. Total estimated cost $1,400,000.
- AML-3 OSM 54 (3703)101.1 North Donaldson I, to backfill 36 acres of surface mine pits, backfill a mine opening and install a monitoring weir on the Colket discharge. A 2,200-foot long dangerous highwall was eliminated. Total cost estimated at $750,000. Completed in 2003.
- AML-4 AMD 54 (3024) 101.1 Tremont North (Indian Head Passive Treatment), to backfill strip mine pits and install an aerobic passive treatment system to treat the Marshfield #1 and #2 outflows with an

average flow of 100 gallons per minute and 150 gallons per minute respectively. The discharges are net alkaline with elevated iron levels. Total cost was estimated at $250,000.

- AML-5 OSM 54 (3022) 101.1 Red Mountain South West, to backfill 25.2 acres of surface mine pits and eliminate 4,500 feet of dangerous highwall. Portions of the project area will be partially backfilled to create 0.4 acres of wetland habitat. Total cost estimated at $140,000.
- AML-6 OSM 54 (3703) 102.1 North Donaldson II, to backfill 48 acres of surface mine pits and mine openings. A total of 2,200 feet of dangerous highwall will be eliminated. Total cost estimated at $750,000.
- AML-7 OSM 54 (3650) 101.1 Newtown South 1, to backfill 32 acres of surface mine pits and three mine openings. A total of 7,200 feet of dangerous highwall will be eliminated. Total cost has been estimated at $200,000.
- AML-8 AMD 54 (3703) 101.1 Colket Dishcarge, to install an aerobic passive treatment system to treat a net alkaline, elevated iron discharge with an average flow of 500 gallons per minute. Total cost has been estimated at $250,000.
- AML-9 AMD 54 (4212) 101.1 Clinton-Tracy Overflow to install an aerobic passive treatment system to treat an outflow known as the Coal Run discharge, with an average flow of 1,250 gallons per minute. These combined discharges are slightly acidic with elevated iron levels. Total cost has been estimated at $250,000.
- AML-10 AMD 54 (4214) 102.1 Clinton Discharge to install an aerobic passive treatment system to treat a net alkaline elevated iron outflow with an average flow of 2,000 gallons per minute. Total cost has been estimated at $250,000.
- AML-11 OSM 54 (3024) 101.1 Tremont North, to backfill 85 acres of surface mine pits and a mine opening. A total of 3,000 feet of dangerous highwall will be eliminated. Total cost has been estimated at $630,000.
- AML-12 OSM 54 3648) 101.1 Blackwood West, to backfill 75 acres of strip mine pits and install passive treatment systems to treat outflows. A total of 6,800 feet of dangerous highwall will be eliminated. Total cost for has been estimated at $1,250,000.
- AML-13 OSM 54 (3703) 103.1 North Donaldson III, to backfill 85 acres of strip mine pits and mine openings. A total of 2,200 feet of dangerous highwall will be eliminated. Total cost has been estimated at $1,000,000.
- AML-14 OSM 54 (3649) 101.1 Newtown South 2, Phase I to backfill 19 acres of strip mine pits and install passive treatment systems to treat outflows. A total of 500 feet of dangerous highwall will be eliminated. Total cost estimated at $250,000.
- AML-15 OSM 54 (3649) 102.1 Newtown South 2, Phase II to backfill 41 acres of strip mine pits and install passive treatment systems to treat outflows. A total of 2,200 feet of dangerous highwall and three hazardous water bodies will be eliminated at an estimated cost $280,000.
- AML-16 OSM 54 (3114) 101.1 Sharp Mountain West, to backfill strip mine pits, mine openings, and construct wetlands to treat discharges. A total of 3,400 feet of dangerous highwall will be eliminated. Total cost is estimated at $500,000.

Summary and Recommendations

The Tracy Airhole and Rowe Tunnel should continue to be a priority for abatement; however, the smaller discharges should not be ignored. The cumulative effect of the smaller discharges impacts the overall quality of the upper Swatara Creek watershed. Each of the subwatersheds is impacted by AMD to varying degrees. Permanent solutions and abatement measures should be pursued wherever possible, such as reclamation of abandoned mines, stream channel restoration, and low maintenance passive systems including constructed wetlands, anoxic limestone drains. Construction of passive treatment systems in conjunction with reclamation of abandoned mine lands and restoration of streams to surface channels, should be the major approach to abating the pollution. Larger discharges such as the Rowe Tunnel discharge, may require active treatment systems, possibly in conjunction with passive systems.

Water quality and biological monitoring should be continued at the same intensity and possibly enhanced in some areas. This information is critical for the continuation of the improvement efforts to assure that the completed projects are working efficiently, to determine the most effective method of treatment or abatement, and for selecting the best location for the systems. Background water quality is necessary for all future projects.

Remining should be encouraged throughout the watershed. Millions of cubic yards of culm material in the watershed continue to produce acid and metals. Removal of these piles will result in water quality improvements in addition to eliminating the potential for coal sediment (black water) storm flow. Remining of abandoned surface mines, daylighting deep mines, and reclamation with materials such as fly ash, may also improve water quality by preventing infiltration of rainwater.

DEP Bureau of Abandoned Mine Reclamation (BAMR) will play an important role in the improvement of water quality. BAMR reclamation projects in the planning or design stage totaling over $8 million. These projects are necessary to further improve the water quality in the headwaters of Swatara Creek and its tributaries.

Continued cooperative between government agencies, local municipalities, watershed groups and citizens is necessary to assure that funding is maximized, projects are completed, and that the public can once again appreciate the valuable resources of their streams.

Water Quality Improvement Cooperators

The water quality improvements in the Swatara Creek watershed would not have been possible without the commitment and cooperation of the following agencies, citizens groups and industries:

Federal:

- U.S. Environmental Protection Agency (EPA)- Providing EPA 319, 104(b)(3) grants that have been the major source of funding for the Swatara cleanup projects.
- U.S. Office of Surface Mining (OSM)- Background water quality and flow data collection on discharges and streams targeted for improvement projects.
- PA Air National Guard 201st Red Horse Civil Engineer Flight- Equipment and construction assistance on the Martin Run Diversion Well project.
- U.S. Department of Agriculture Natural Resource Conservation Service (NRCS)- Providing technical assistance in remediation site review, survey and design.
- U.S. Department of Energy (USDOE)- Partner in a project to develop a treatment system on Lorberry Creek in the Swatara Creek watershed which may have application throughout the Anthracite Region.
- US Geologic Survey (USGS)- A multiyear effort to monitor and assess stream quality improvements and the effectiveness of water treatment systems individually and cumulatively, and to provide technical assistance in designing pollution abatement systems. Instrumental in having Swatara Creek recognized under the US EPA 319 National Monitoring Program.

State:

- DCNR Bureau of State Parks had responsibility for coordination all efforts concerning the proposed lake at Swatara State Park. The dam to create the lake is no longer scheduled to be built. The Bureau of State Parks also assisted in the design and construciton of the Lorberry Junction Wetland project.
- DEP Bureau of Abandoned Mine Reclamation (Wilkes-Barre BAMR)- Construction of the Lorberry Junction Wetland. Currently designing numerous large scale reclamation projects in Middle Creek and Upper Swatara Creek subwatersheds. BAMR is also a key part of negotiations to divert the Tracy Airhole to the Rausch Creek Treatment Plant.
- DEP Bureau of Waterways Engineering- Providing technical assistance and cooperation in the mine drainage abatement efforts.

- DEP Bureau of Watershed Management- Assisting and appropriating EPA 319 and other funding sources for mine drainage abatement projects. The key funding sources for the EPA 319 National Monitoring Program Project.
- DEP Bureau of Water Supply and Waste Water Management- Data collection and assessment of water quality improvements both biological and chemical.
- DEP Bureau of Mining and Reclamation- Assisting and appropriating EPA 104(b)(3) funds for mine drainage abatement projects.
- DEP District Mining Operations (Pottsville DMO)- Coordinating the water quality improvement effort in the mine drainage affected areas, data collection, assisting to acquire funding for abatement projects, encouraging remining, provide technical assistance and project design, integrating with the local community.
- PA Fish and Boat Commission- Assisted in aquatic surveys.
- PennDOT - Cooperating as the landowner and assisting in the Lorberry Junction Wetland Project.

Local:

- Schuylkill County Conservation District (SCCD)- Primary funding administrator for water quality improvement projects and providing technical assistance in project design. Coordinating the water quality improvement effort in the mine drainage affected areas, data collection, assisting to acquire funding for abatement projects. Also involved in nutrient management and streambank stabilization in the farming areas near Pine Grove.
- Schuylkill County- Identification of landowners, seeking funding for stream improvement projects and assistance in project design. Also, one of the key funding sources for the EPA 319 National Monitoring Program Project.
- Municipalities- Reilly Township, Frailey Township and Tremont Borough have participated in and are cooperating in the mine drainage abatement efforts. They have provided equipment, maintenance, and permission to install treatment structures.
- Watershed Associations- The Swatara Creek Watershed Association (SCWA) focuses of the entire Swatara Watershed, which includes 4 counties, emphasizes water quality improvements in addition to recreational improvements in the watershed. The Northern Swatara Creek Watershed Association (NSCWA) focuses primarily upper part of the watershed in Schuylkill County and addresses the mine drainage pollution. The associations work together on stream improvement projects and watershed awareness.
- Organizations- Trout Unlimited (Schuylkill County Chapter), Schuylkill County Sportsman's Association, Little Run Sportsman's Club and local citizens have donated time, equipment, and supplies to aid in the treatment efforts.
- Industry- The local industries have been very cooperative and several have expressed interest in participating when they are needed. The Pennsylvania Coal Association (PAC), several coal companies, limestone quarries, landfills, and several local businesses have donated supplies, services, and expertise on many of the water quality restoration projects. Carmuese, PA Limestone Quarry, Hegins Mining Company, Harriman Coal Corporation, Blaschak Coal Corporation, White Pine Coal Company, Angelo and Reber Trucking, Commonwealth Environmental Services Landfill, and the Pine Grove Landfill are some of the industries that have donated services or equipment.