Final

LITTLE SCHUYLKILL RIVER WATERSHED TMDL

Schuylkill County

For Acid Mine Drainage and Siltation Affected Segments

Prepared by:

Pennsylvania Department of Environmental Protection

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ATTACHMENTS

[1]Table 1 – Impaired Segments in the Little Schuylkill River Watershed

Hydrologic Unit Code: 02040203 - Schuylkill

2015

Beaver Creek (Unt 02228)
HUC: 02040203

Aquatic Life (1014) - 2.19 miles; 8 Segment(s)*			
Agriculture	Siltation	2002	2015

Cold Run
HUC: 02040203

Aquatic Life (1307) - 0.02 miles; 1 Segment(s)*			
Abandoned Mine Drainage	Metals	1996	2009
Abandoned Mine Drainage	pH	1996	2009
Abandoned Mine Drainage	Siltation	2002	2015
Abandoned Mine Drainage	Suspended Solids	1996	2009
Aquatic Life (1308) - 0.19 miles; 3 Segment(s)*			
Abandoned Mine Drainage	Metals	2002	2015
Abandoned Mine Drainage	pH	2002	2015
Abandoned Mine Drainage	Suspended Solids	2002	2015

Little Schuylkill River
HUC: 02040203

Aquatic Life (1307) - 22.30 miles; 56 Segment(s)*			
Abandoned Mine Drainage	Metals	1996	2009
Abandoned Mine Drainage	pH	1996	2009
Abandoned Mine Drainage	Siltation	2002	2015
Abandoned Mine Drainage	Suspended Solids	1996	2009

Little Schuylkill River (Unt 02233)
HUC: 02040203

Aquatic Life (1308) - 1.68 miles; 4 Segment(s)*			
Abandoned Mine Drainage	Metals	2002	2015
Abandoned Mine Drainage	pH	2002	2015
Abandoned Mine Drainage	Suspended Solids	2002	2015

Little Schuylkill River (Unt 02245)
HUC: 02040203

Aquatic Life (1308) - 1.07 miles; 9 Segment(s)*			
Abandoned Mine Drainage	Metals	2002	2015
Abandoned Mine Drainage	pH	2002	2015
Abandoned Mine Drainage	Suspended Solids	2002	2015

Panther Creek
HUC: 02040203

Aquatic Life (719) - 6.49 miles; 5 Segment(s)*			
Abandoned Mine Drainage	Metals	1996	2009

Stream Name Use Designation (Assessment ID) Source	Cause	Date Listed	TMDL Date
<u>Panther Creek</u> HUC: 02040203			
Aquatic Life (719) - 6.49 miles; 5 Segment(s)*			
Surface Mining	Siltation	1998	2011
<u>Wabash Creek</u> HUC: 02040203			
Aquatic Life (714) - 2.03 miles; 5 Segment(s)*			
Abandoned Mine Drainage	Metals	1996	2009
Abandoned Mine Drainage	Siltation	2002	2015
Abandoned Mine Drainage	pH	1996	2009
Abandoned Mine Drainage	Siltation	2002	2015
Abandoned Mine Drainage	Suspended Solids	1996	2009

Report Summary

Watershed Summary

	Stream Miles	Assessment Units	Segments (COMIDs)
Watershed Characteristics	196.33	6	512

Impairment Summary

Source	Cause	Miles	Assessment Units	Segments (COMIDs)
Abandoned Mine Drainage	Metals	34.79	4	97
Abandoned Mine Drainage	Siltation	25.37	2	76
Abandoned Mine Drainage	Suspended Solids	25.87	2	84
Abandoned Mine Drainage	pH	25.87	2	84
Agriculture	Siltation	2.19	1	8
		38.56 **	**6****	**108** **

**Totals reflect actual miles of impaired stream. Each stream segment may have multiple impairments (different sources or causes contributing to the impairment), so the sum of individual impairment numbers may not add up to the totals shown.

Use Designation Summary

	Miles	Assessment Units	Segments (COMIDs)
Aquatic Life	38.56	6	108

Introduction

This report presents the Total Maximum Daily Loads (TMDLs) developed for segments in the Little Schuylkill River Watershed (Attachment A) by the Pennsylvania Department of Environmental Protection (DEP). These TMDLs were done to address the impairments noted on Pennsylvania's lists of impaired waters from 1996 through 2010, required under the Clean Water Act. High levels of metals, suspended solids, and in some areas low pH, caused these impairments. All impairments resulted from acid drainage from abandoned coalmines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and pH and was originally approved by the U.S. Environmental Protection Agency (EPA) in March 2007. It is being revised to reflect significant changes in data and other information used to derive the 2007 TMDL and to make it consistent with the pending revision of the Panther Creek TMDL, a tributary of the Little Schuylkill River. The original Little Schuylkill River TMDL did not account for changes in flow from the resumption of pumping and discharge into Panther Creek, therefore, the TMDL is being revised using flow and water quality data collected by USGS just downstream of the confluence of Panther Creek and the Little Schuylkill River. Additionally, the revision to both the Little Schuylkill and Panther Creek TMDLs account for the new treatment proposal of the Route 309 discharge.

Directions to the Little Schuylkill River Watershed

The Little Schuylkill River Watershed is approximately 53.4 square miles in area. It is located in eastern Schuylkill County, about a mile south of Haddock, Pennsylvania. The Little Schuylkill River flows 31.44 miles south from its headwaters near Haddock in Kline Township, Schuylkill County to its confluence with the Schuylkill River at Port Clinton in West Brunswick Township, Schuylkill County. The Little Schuylkill River can be accessed by traveling on Interstate 81 to State Route 309 in Hazleton, Pennsylvania.

Segments addressed in this TMDL

The Little Schuylkill River Watershed is affected by pollution from acid mine drainage (AMD). This pollution has caused high levels of metals and low pH in the mainstem of the Little Schuylkill River at numerous sources as well as from two tributaries, the Wabash and Panther Creeks. AMD begins near the headwaters from the Silverbrook Discharge. Sources of AMD are nonexistent once the Little Schuylkill River flows south of Sharp Mountain and out of the Southern Anthracite coalfield.

There are active mining operations with NPDES permits in the watershed (Table 2). All of the discharges in the watershed from abandoned mines will be treated as non-point sources, except for one large discharge (NPDES permit # PA0012360). Each segment on the Section 303(d) list will be addressed as a separate TMDL. These TMDLs will be expressed as long-term, average loadings. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average results in a more meaningful representation of the data used to develop the TMDL. See Attachment C for TMDL calculations.

Clean Water Act Requirements

Section 303(d) of the 1972 Clean Water Act requires states, territories, and authorized tribes to establish water quality standards. The water quality standards identify the uses for each waterbody and the scientific criteria needed to support that use. Uses can include designations for drinking water supply, contact recreation (swimming), and aquatic life support. Minimum goals set by the Clean Water Act require that all waters be "fishable" and "swimmable."

Additionally, the federal Clean Water Act and the EPA's implementing regulations (40 CFR Part 130) require:

* States to develop lists of impaired waters for which current pollution controls are not stringent enough to meet water quality standards (the list is used to determine which streams need TMDLs);

* States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;

* States to submit the list of waters to EPA every two years (April 1 of the even numbered years);

* States to develop TMDLs, specifying a pollutant budget that meets state water quality standards and allocate pollutant loads among pollution sources in a watershed, e.g., point and non-point sources; and

* EPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

Despite these requirements, states, territories, authorized tribes, and EPA have not developed many TMDLs. Beginning in 1986, organizations in many states filed lawsuits against the EPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While EPA has entered into consent agreements with the plaintiffs in several states, many lawsuits still are pending across the country.

In the cases that have been settled to date, the consent agreements require EPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., AMD, implementation of non-point source Best Management Practices (BMPs), etc.).

These TMDLs were developed in partial fulfillment of the 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA*.

Section 303(d) Listing Process

Prior to developing TMDLs for specific waterbodies, there must be sufficient data available to assess which streams are impaired and should be on the Section 303(d) list. With guidance from the EPA, the states have developed methods for assessing the waters within their respective jurisdictions.

The primary method adopted by DEP for evaluating waters changed between the publication of the 1996 and 1998 Section 303(d) lists. Prior to 1998, data used to list streams were in a variety of formats, collected under differing protocols. Information also was gathered through the Section 305(b)[2] reporting process. DEP is now using the Statewide Surface Waters Assessment Protocol (SSWAP), a modification of the EPA's 1989 Rapid Bioassessment Protocol II (RBP-II), as the primary mechanism to assess Pennsylvania's waters. The SSWAP provides a more consistent approach to assessing Pennsylvania's streams.

The assessment method requires selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment can vary between sites. All the biological surveys included kick-screen sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates are identified to the family level in the field.

After the survey is completed, the biologist determines the status of the stream segment. The decision is based on the performance of the segment using a series of biological metrics. If the stream is determined to be impaired, the source and cause of the impairment is documented. An impaired stream must be listed on the state's Section 303(d) list with the source and cause. A TMDL must be developed for the stream segment and each pollutant. In order for the process to be more effective, adjoining stream segments with the same source and cause listing are addressed collectively, and on a watershed basis.

Basic Steps for Determining a TMDL

Although all watersheds must be handled on a case-by-case basis when developing TMDLs, there are basic processes or steps that apply to all cases. They include:

1. Collection and summarization of pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculating TMDL for the waterbody using EPA approved methods and computer models;
3. Allocating pollutant loads to various sources;
4. Determining critical and seasonal conditions;

[2] Section 305(b) of the Clean Water Act requires a biannual description of the water quality of the waters of the state.

5. Public review and comment period on draft TMDL;
6. Submittal of final TMDL to EPA.
7. EPA approval of the TMDL.

Watershed History

The Little Schuylkill Watershed drains approximately 53.4 square miles, with approximately 31.44 miles of stream that ultimately flows into the Schuylkill River. The watershed is located in State Water Plan subbasin 3A; the protected use is aquatic life. Little Schuylkill River watershed is designated as Cold Water Fishes (CWF) and Migratory Fishes (MF) under §93.9f in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2002).Abandoned mine areas are dominant in the northern portion of the watershed. Besides the AMD from Wabash and Panther Creeks, the watershed receives sources of AMD from two topographical basins known as the Silverbrook and Tamaqua Basins. The Silverbrook Basin contains less than a mile of the stream. The Tamaqua Basin, which begins approximately 7.2 miles downstream from the Silverbrook Basin, contains a 1.5-mile reach of stream.

AMD into the watershed is primarily from deep mine pools, both abandoned and active mines. The largest of these pools is the Silverbrook Mine pool, which underlies most of the Silverbrook Basin. Smaller deep mine pools are situated on the west side of the Little Schuylkill River at the water gaps north and south of Tamaqua Borough. All five pools extend for some distance into the Wabash Valley and, therefore, drain a portion of the groundwater from this valley.

The surface in the Silverbrook Basin has been almost completely destroyed by surface and deep mining. Similar activities on both sides of the water gaps at Tamaqua have destroyed the surface in these areas as well. The Silverbrook Basin has been an area of very extensive deep mining below present water level. As a result of abandonment, 80 to 90% of the deep mine workings are now inundated, forming a huge pool of acid mine water underlying much of the basin.

The headwaters of the Little Schuylkill River are in the Silverbrook Basin and the overflow (Silverbrook Discharge) from the mine pool is a large part of the flow for the River at this point. The point of discharge is on the bank of the stream 200 feet east of State Route 309. The mine flow emanates from the base of a refuse bank, which conceals a possible portal.

Immediately adjacent to the east of the Silverbrook Discharge is an active surface mining permit issued to Northeastern Power Company (NEPCO). The surface mining permit covers 876 acres and consists mainly of loading and transporting existing supplies of coal refuse as fuel for the onsite fluidized bed cogeneration plant. Also, included with the operations is the reclamation of existing onsite abandoned mining areas with placement of coal ash. Also immediately adjacent to the west of the Silverbrook Discharge along the bank of the Little Schuylkill River are two (2) limestone diversion wells constructed by PADEP; the majority of the water from discharge is redirected to these wells. The first well was placed in the spring of 1996 and the second in the fall of 1998. The wells are no longer being maintained.

Within the Tamaqua Basin, a large AMD discharge, the Buck Drift Discharge (aka. Route 309 discharge), flows from a buried deep mine opening south of Tamaqua, on the east side of State

Route 309 along the north side of Pisqah Mountain (one mile south of the intersection of SR 209 and SR 309 in Tamaqua). The discharge is believed to drain four (4) interconnected deep mine pools, named Tamaqua, Greenwood, Rahn and Coaldale, extending from Tamaqua eastward to Coaldale (Taylor 1988). The Buck Drift Discharge was not continuous before 2001.

Prior to 2001 the Lehigh Coal and Navigation Company (LCN) pumped the mine pools to facilitate its anthracite strip mining operations, treated the pumped water and discharged it to Panther Creek approximately one mile east of the location of the Buck Drift Discharge. When LCN ceased pumping the mine pools in 2001 due to financial problems, the pressure within the mine pools increased, the levels began to rise and a continuous volume of mine drainage emerged at the Buck Drift. Severe precipitation events also influenced the levels within the mine pools and the volume discharging at the Buck Drift. LCN treated the increased volume of mine drainage in a 4 acre sedimentation pond that was constructed as part of the DEP Bureau of Abandoned Mine Reclamation's Pisgah Ridge West AML project. LCN's Route 309 Treatment Facility discharged to the Little Schuylkill River at Outfall 005 (the Route 309 Discharge) pursuant to NPDES Permit No. PA0012360. LCN's NPDES Permit was renewed in 2007 after the approval of the Little Schuylkill River TMDL, and water quality-based effluent limitations were imposed at the treatment facility.

The Buck Drift Discharge presents a threat to public health and safety due to its proximity to Route 309, businesses and utility lines. There are other potential discharges of mine drainage from unknown abandoned underground mine workings in the area that have the potential to discharge at unpredictable locations. The BAMR sedimentation pond was never designed to contain and treat the volume of water emerging at the Buck Drift and there were geographic limitations on expanding it. LCN exceeded the effluent limitations for the Route 309 Treatment Facility on numerous occasions.

An involuntary petition for relief under the U.S. Bankruptcy Code was filed against LCN on July 15, 2008, and LCN subsequently consented to an August 26, 2008 order by the U.S. Bankruptcy Court for the Middle District of Pennsylvania (Bankruptcy Court). BET Associates IV, LLC (BET Associates) and BET Lehigh Real Estate, LLC acquired all of LCN's assets in a sale approved by the Bankruptcy Court on May 27, 2010. Subsequent to the sale of LCN assets, BET Associates entered into a May 5, 2011 consent order and agreement with DEP whereby BET Associates agreed to operate the Route 309 Treatment Facility in the interim and develop permanent plans for the relocation of all or part of the Route 309 Discharge. LCN's mining and NPDES permits were transferred to BET Associates in 2011.

As required by the 2011 consent order and agreement, BET Associates submitted a proposal to relocate and treat all or part of the Route 309 Discharge. The proposal involved pumping the mine pools, construction of a new treatment system in an area adjacent to Panther Creek, and re-authorization of discharges from Outfalls 001, 003 and 004 into Panther Creek. BET Associates also submitted an application to modify NPDES Permit No. 0012360 to incorporate this proposal. Resuming pumping in the Panther Creek watershed will lower the mine pools and eliminate or substantially reduce the discharge from the Buck Mountain Drift location, thus preventing any threat to public health and safety. The Panther Creek TMDL was developed and approved after LCN ceased pumping the mine pools. The TMDL did not account for flows from the resumption of pumping, and, consequently, DEP has developed a revised Panther Creek TMDL (DEP 2012). Similarly, the Little Schuylkill River TMDL did not account for flows from the resumption of pumping and discharge into Panther Creek and it is being revised to reflect the changes in flows contributed from Panther Creek and the Route 309 Discharge as a result of the new treatment proposal.

There are currently six (6) active coal mining permits in the watershed (see Table 2). All of these mining permits involve remining of underground surface mine works. The operators are reclaiming piles of previously unusable refuse (culm) bank material and reprocessing it to turn it into a fuel source. The BET Associates site also involves surface mining of anthracite coal deposits. It should be noted that discharges from ponds in this area are rare, as much of the surface runoff percolates down into the extensive underground mining works that underlay the valley. For the mining sites that do not hold NPDES permits, no waste load allocation has been assigned due to the lack of a discharge. Only Outfall 005 on the BET Associates permit is actively discharging, therefore a WLA (Waste Load Allocation) has been calculated. In order to mine deeper coal reserves, BET has proposed the installation of two high capacity pumps that will draw down the water elevation in the underground mine works, and at the same time dry up an existing discharge to surface waters from an abandoned mule hole (abandoned underground mine entrance) along Highway 309. Premium Fine Coal, Inc. (NPDES #PA0593486) and South Tamaqua Coal Pockets, Inc. (NPDES #PA0613631) have NPDES permits for erosion and sedimentation only. The sedimentation ponds have no recorded discharges and have not been assigned waste load allocations. It has been determined that effects from the sedimentation ponds in this area are negligible because much of their discharge percolates down into the underground mine works and the ponds should rarely discharge if reclamation and revegetation is concurrent. In addition, sedimentation ponds are designed in accordance with PA Code Title 25 Chapter 88.98 to, at a minimum, contain runoff from a 10-year 24-hour precipitation event.

Table 2. Mining Permits in the Little Schuylkill Watershed

Permittee	*Permit Number*	*Status*	*NPDES*
Mazaika Coal Company	54840209	Coal preparation plant on site.	PA0224804
Premium Fine Coal, Inc.	54860204	Coal preparation plant on site. NPDES permit for a sedimentation pond. No reported discharge.	PA0593486
Gale Mining, Inc.	54921601	Coal preparation plant on site.	PA0224847
Northeastern Power Company	54920201	No NPDES permit. Cogeneration plant, refuse reprocessing, and coal ash placement are active on this site.	N/A
South Tamaqua Coal Pockets, Inc.	54830209	Coal preparation plant on site. NPDES permit for a sedimentation pond. No reported discharge.	PA0613631
BET Associates IV,	54733020	Coal preparation plant on site.	PA0012360

LLC.		Surface mining, refuse reprocessing and coal ash placement are active on this site. NPDES permit for Outfall 005.	

∗ Please see Table 8 for non-mining NPDES permits in the Little Schuylkill Watershed

A biological survey conducted by DEP's Water Management Program (Daley 2003) for the Little Schuylkill River in the Tamaqua area showed moderate impairment. The stations below Panther Creek, Wabash Creek, and the Buck Drift Discharge showed a reduction of abundance and diversity of benthic organisms compared to the station above these influences, attributed to the effects of AMD. However, overall improvement was noted, since no populations were found during a survey in 1984. The construction of treatment facilities and reclamation projects was stated as a reason for the gradual improvement in the water quality over the years.

AMD Methodology

A two-step approach is used for the TMDL analysis of impaired stream segments. The first step uses a statistical method for determining the allowable instream concentration at the point of interest necessary to meet water quality standards. This is done at each point of interest (sample point) in the watershed. The second step is a mass balance of the loads as they pass through the watershed. Loads at these points will be computed based on average annual flow unless otherwise indicated.

The statistical analysis described below can be applied to situations where all of the pollutant loading is from non-point sources as well as those where there are both point and non-point sources. The following defines what are considered point sources and non-point sources for the purposes of our evaluation; point sources are defined as permitted discharges, non-point sources are then any pollution sources that are not point sources. For situations where all of the impact is due to non-point sources, the equations shown below are applied using data for a point in the stream. The load allocation made at that point will be for all of the watershed area that is above that point. For situations where there are point-source impacts alone, or in combination with non-point sources, the evaluation will use the point-source data and perform a mass balance with the receiving water to determine the impact of the point source.

Allowable loads are determined for each point of interest using Monte Carlo simulation. Monte Carlo simulation is an analytical method meant to imitate real-life systems, especially when other analyses are too mathematically complex or too difficult to reproduce. Monte Carlo simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distribution of the uncertain variables and using those values to populate a larger data set. Allocations were applied uniformly for the watershed area specified for each allocation point. For each source and pollutant, it was assumed that the observed data were log-normally distributed. Each pollutant source was evaluated separately using @Risk[3] by performing 5,000

[3] @Risk – Risk Analysis and Simulation Add-in for Microsoft Excel, Palisade Corporation, Newfield, NY, 1990-1997.

iterations to determine the required percent reduction so that the water quality criteria, as defined in the *Pennsylvania Code. Title 25 Environmental Protection, Department of Environmental Protection, Chapter 93, Water Quality Standards,* will be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

PR = maximum {0, (1-Cc/Cd)} where (1)

PR = required percent reduction for the current iteration

Cc = criterion in mg/l

Cd = randomly generated pollutant source concentration in mg/l based on the observed data

Cd = RiskLognorm(Mean, Standard Deviation) where (1a)

Mean = average observed concentration

Standard Deviation = standard deviation of observed data

The overall percent reduction required is the 99th percentile value of the probability distribution generated by the 5,000 iterations, so that the allowable long-term average (LTA) concentration is:

LTA = Mean * (1 – PR99) where (2)

LTA = allowable LTA source concentration in mg/l

Once the allowable concentration and load for each pollutant is determined, mass-balance accounting is performed starting at the top of the watershed and working down in sequence. This mass-balance or load tracking is explained below.

Load tracking through the watershed utilizes the change in measured loads from sample location to sample location, as well as the allowable load that was determined at each point using the @Risk program.

There are two basic rules that are applied in load tracking; rule one is that if the sum of the measured loads that directly affect the downstream sample point is less than the measured load at the downstream sample point it is indicative that there is an increase in load between the points being evaluated, and this amount (the difference between the sum of the upstream and downstream loads) shall be added to the allowable load(s) coming from the upstream points to give a total load that is coming into the downstream point from all sources. The second rule is that if the sum of the measured loads from the upstream points is greater than the measured load at the downstream point this is indicative that there is a loss of instream load between the evaluation points, and the ratio of the decrease shall be applied to the load that is being tracked (allowable load(s)) from the upstream point.

Tracking loads through the watershed gives the best picture of how the pollutants are affecting the watershed based on the information that is available. The analysis is done to insure that water quality standards will be met at all points in the stream. The TMDL must be designed to meet standards at all points in the stream, and in completing the analysis, reductions that must be made to upstream points are considered to be accomplished when evaluating points that are lower in the watershed. Another key point is that the loads are being computed based on average annual flow and should not be taken out of the context for which they are intended, which is to depict how the pollutants affect the watershed and where the sources and sinks are located spatially in the watershed.

In pH TMDLs, hot acidity is compared to alkalinity as described in Attachment B. Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total hot acidity. Net alkalinity is alkalinity minus hot acidity, both in units of milligrams per liter (mg/l) $CaCO_3$. Statistical procedures are applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for streams affected by low pH may not represent a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

Information for the TMDL analysis performed using the methodology described above is contained in the "TMDLs by Segment" section of this report.

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of applicable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for comparison between observed instream conditions and conditions that are expected to restore designated uses. Pennsylvania does not currently have specific numeric criteria for sediment. Therefore, to establish endpoints such that the designated uses of the Little Schuylkill River watershed are attained and maintained, Pennsylvania utilizes its narrative water quality criteria, which states that:

Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life.

For the pollution sources in the watershed that are nonpoint sources, the TMDL is expressed as Load Allocations (LAs). The TMDL is expressed as a Waste Load Allocation (WLA) for the point sources of pollution in the watershed. All allocations will be specified as long-term average daily concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time as required in PA Title 25 Chapter 96.3(c). The following table shows the applicable water-quality criteria for the selected parameters.

Table 3. Applicable Water Quality Criteria

Parameter	***Criterion Value (mg/l)***	***Total Recoverable/Dissolved***
Aluminum (Al)	0.75	Total Recoverable
Iron (Fe)	1.50	30-day average; Total
Manganese (Mn)	1.00	Total Recoverable
pH *	6.0-9.0	N/A
Sediment	Derived from interpretation of narrative criteria/Reference Watershed Approach	N/A

*The pH values shown will be used when applicable. In the case of freestone streams with little or no buffering capacity, the TMDL endpoint for pH will be the natural background water quality. These values are typically as low as 5.4 (Pennsylvania Fish and Boat Commission).

TMDL Elements (WLA, LA, MOS)

$$TMDL = WLA + LA + MOS$$

A TMDL equation consists of a wasteload allocation, load allocation and a margin of safety. The wasteload allocation is the portion of the load assigned to point sources. The load allocation is the portion of the load assigned to non-point sources. The margin of safety is applied to account for uncertainties in the computational process. The margin of safety may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load). The TMDL allocations in this report are based on available data. Other allocation schemes could also meet the TMDL. Table 9 contains the TMDL component summary for each point evaluated in the watershed. Refer to the maps in Attachment A.

Siltation Impairment and Allocation Summary

The suspended solids, or siltation, impairment noted in Little Schuylkill River is due to runoff from large refuse piles (culm banks) from historic mining and croplands located throughout the watershed. Refuse piles are also abundant along Panther Creek and Wabash Creek, two large tributaries to Little Schuylkill River. An existing sediment load was computed using the Generalized Watershed Loading Function (GWLF) model. This model is being used by the Department to address sedimentation/siltation/suspended solids problems in other watersheds throughout the Commonwealth.

The “Reference Watershed Approach” is used to determine the sediment load reduction needed for this watershed. The Reference Watershed Approach compares two watersheds, one attaining its designated uses and one that is impaired based on biological assessments. Both watersheds must have similar land use/cover distributions. 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 pollutants in the impaired stream segment to a level equivalent to, or slightly lower than, the loading rate in the non-impaired, reference segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments.

In general, three factors are considered when selecting a suitable reference watershed. The first factor is to use a watershed that the Department has assessed and determined to be attaining water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, physiographic province, and geology. Finally, the size of the reference watershed should be within 20-30% of the impaired watershed area. The search for a reference watershed for Little Schuylkill River that would satisfy the above characteristics was done by means of a desktop screening using several GIS coverages, including the Multi-Resolution Land Characteristics (MRLC), Landsat-derived land cover/use grid, the Pennsylvania's 305(b) assessed streams database, and geologic rock types.

Meshoppen Creek Watershed was selected for use as the reference watershed. The watershed is located in State Water Plan subbasin 4G; the protected use is aquatic life. Meshoppen Creek Basin is designated as Cold Water Fishes (CWF) under §93.9i in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2002). Based on the Department's 305(b) report database, Meshoppen Creek Watershed is currently attaining its designated uses. The attainment of designated uses is based on sampling done by the Department in 2000, using the Unassessed Waters Program protocol. A map of the Meshoppen Creek Watershed is located in Attachment A.

Drainage area, location, land use and other physical characteristics such as geology and rock types of the Little Schuylkill River Watershed were compared to the Meshoppen Creek Watershed. An analysis of the available characteristics revealed that while land cover/use distributions are not an exact match, the watersheds are similar.

A suspended solids/siltation TMDL for the Little Schuylkill River Watershed was developed using the ArcView Generalized Watershed Loading Function (AVGWLF) model as described in Attachment E. The AVGWLF model was used to establish existing loading conditions for the Little Schuylkill River Watershed and the Meshoppen Creek Reference Watershed. All modeling outputs have been included in Attachment G. A 10% explicit MOS was taken to account for uncertainty in the modeling and loading estimates.

The sediment reduction goal for the TMDL is based on setting the watershed-loading rate of the impaired Little Schuylkill River equal to the watershed-loading rate in the un-impaired Meshoppen Creek Watershed. The load reduction for suspended solids in Little Schuylkill River was assigned to the land use categories coal mines/quarry and croplands.

The TMDL for sediment results in a 35% reduction in loading from croplands and 42% from coal mine/quarry. A more detailed explanation of sediment calculations is contained in Attachment D. The individual components of the TMDL are summarized in Table 4 and the load allocation summary is given in Table 5.

Table 4. TMDL, WLA, MOS, LA, LNR, and ALA for Little Schuylkill River Watershed		
Component	Sediment (lbs/yr.)	Sediment (lbs/day)
TMDL (Total Maximum Daily Load)	96,205,299	263,576
WLA (Waste Load Allocation)*	3,463,121	9,488
MOS (Margin of Safety)	9,620,530	26,357
LA (Load Allocation)	83,121,648	227,731
LNR (Loads Not Reduced)	16,497,140	45,198
ALA (Adjusted Load Allocation)	66,624,508	182,533

* Comprised of permitted suspended solids loads to BET Associates (SMP54733020, NPDES PA0012360) of 4203 lbs/day or 1,534,226 lbs/year, Maziaka Coal Company of 13 lbs/day or 4,745 lbs/day, and 2% bulk allocation was included to account for general permits or other contributors that are present now or in the future.

Table 5. Sediment Source Load Allocation Summary for Little Schuylkill River Watershed			
Source	Current Loading (lbs/yr.)	Allowable Loading (lbs/yr.)	Percent Reduction (%)
COAL_MINES/QUARRY	74,456,180	43,317,398	42%
CROPLAND	35,847,600	23,307,110	35%
NPS Loads Not Reduced	16,497,140	16,497,140	-
Total	126,800,920	83,121,648	34%

Metals/Acidity Impairment and Allocation Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. The reduction schemes in Table 10 for each segment are based on the assumption that all upstream allocations are achieved and also take into account all upstream reductions. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. An implicit margin of safety (MOS) based on conservative assumptions in the metals/acidity analysis is included in the TMDL calculations.

The allowable LTA concentration in each segment is calculated using Monte Carlo Simulation as described previously. The allowable load is determined by multiplying the allowable concentration by the flow and a conversion factor at each sample point. The allowable load is the TMDL and each TMDL includes upstream loads.

Each permitted discharge in a segment is assigned a waste load allocation and the total waste load allocation for each segment is included in this table. The difference between the TMDL and the WLA is the load allocation (LA) at any given point. The LA at each point includes all loads entering the segment, including those from upstream allocation points. The percent reduction is calculated to show the amount of load that needs to be reduced to the area upstream of the point in order for water quality standards to be met at the point.

In some instances, instream processes such as settling, are taking place within a stream segment. These processes are evidenced by a decrease in measured loading between consecutive sample points. It is appropriate to account for these losses when tracking upstream loading through a segment. The calculated upstream load lost within a segment is proportional to the difference in the measured loading between the sampling points**.**

In the instance that the allowable load is equal to the measured load (e.g. manganese LS4, Table 10), the simulation determined that water quality standards are being met instream and therefore no TMDL is necessary for the parameter at that point. Although no TMDL is necessary, the loading at the point is considered at the next downstream point. This is denoted as "NA" in the table. "ND" was used to represent sample data which was found to be below detection levels or where no data was measured at a sample point.

A Waste Load Allocation is being assigned at LS6 to Mazaika Coal Company (NPDES PA0224804, SMP 54840209) for one outfall associated with surface mining.

A Waste Load Allocation is being assigned at LS7 to Tamaqua Area Water Authority – Still Creek WTP for one outfall associated with water treatment.

An additional Waste Load Allocation is being assigned at LS11 to BET Associates (SMP54733020, NPDES PA0012360). This WLA is associated with a permit that will contain up to four treatment outfalls (three discharging to Panther Creek and one to the Little Schuylkill) and two stormwater outfalls/sedimentation ponds. To be conservative, the entire WLA was assigned to Panther Creek in a separate TMDL in the event that the discharges are entirely into Panther Creek at a given time. The BET Associates treatment system will vary pumping rates, so the possibility exists that there will be simultaneous discharges from the Route 309 Discharge/Outfall 005 into the Little Schuylkill River and from Outfalls 001, 003, or 004 into Panther Creek (see Attachment A for outfall location). Table 6 shows the WLA for the combined Panther Creek and Little Schuylkill River discharge points, but only to account for the instances when BET Associates is discharging from outfalls in both watersheds. The intent is not to allocate the same load to outfalls in both watersheds (i.e. the entire allocated wasteload for all BET Associates outfalls combined is shown in Table 6), rather it represents the worst case scenario when the entire discharge is coming from outfall(s) in one watershed. The allowable loads for Al, Fe and Mn in BET's discharge were calculated to meet water quality standards at all points instream, including the nearest potable water supply intake (Pottstown Borough Water Authority approximately 65 miles downstream).

Table 6. Combined Waste Load Allocations for Outfalls 001, 003, 004 and 005

	Average Flow (MGD)	Allowable Load (lbs/day)
Al	14.4	90.1
Fe	14.4	180.1
Mn	14.4	168.0
TSS	14.4	4,203

Table 7. Waste Load Allocations for Mazaika Coal NPDES PA0224804		
	Average Flow (MGD)	Allowable Load (lbs/day)
Fe	0.0445	1.11
Mn	0.0445	0.74
TSS	0.0445	13.00

Table 8. Waste Load Allocations for Tamaqua Water Authority – Still Creek WTP NPDES PA0063053		
	Design Flow (MGD)	Allowable Load (lbs/day)
Fe	0.19	3.17
Al	0.19	6.34
Mn	0.19	1.58

The permits shown in Table 9 are within the boundaries of the Little Schuylkill River Watershed, but are not receiving individual wasteload allocations in this TMDL document. In most cases, an aggregate wasteload allocation of 2% of the total allowable load will be set aside to account for any trace amounts of the pollutants of concern at any time from these discharges. These discharges fall into one of two categories: 1) permits with non-numeric effluent limitations; and 2) permits that have numeric effluent limitations for some parameters but do not contain numeric effluent limits for the parameters of concern addressed in this TMDL document. The reasons these discharges have not received individual wasteload allocations include one or more of the following:

1) This class of discharge is not a significant contributor of pollutants of concern as addressed in the TMDL,
2) The discharge concentration is at or below the level of the instream water quality criterion value for the parameters of concern,
3) The discharge does not cause or contribute to a downstream impairment, or
4) The discharge has been evaluated via the reasonable potential analysis to discharge the pollutants of concern at current levels.

Table 9. NPDES permits in the Little Schuylkill River Watershed not receiving individual waste load allocations for metals		
NPDES Permit	**Facility Name**	**Sample Point**
PA0012742	ICI Explosives USA, Inc. Copperhead Chem Tamaqua Pl	LSNR
PA0026476	Coaldale Lansford Summit Hill Sew Auth	LS11
PA0027006	Tamaqua Boro Schuylkill County WWTP	LS11, LSNR
PA0032077	PA DCNR Tuscarora State Park Sew	LS8
PA0032131	PA DCNR Locust Lake State Park	LS8
PA0060739	Brenda & Stephen Dziedziak White Diner	LSNR
PA0061310	Marion High School STP	LS8
PA0061417	Northeastern Power Co.	LS1 (Outfalls 1,2), LS6 (Outfall 3)
PA0062111	Mahanoy Area Joint Industrial Corporation MAJIC TP	LS7
PA0063126	Artex, Inc.	LS8

PA0063878	Northeastern Schuylkill Joint Muni Auth WWT	LS8
PA0064157	New Ringgold Boro WWTP	LS13
PA0064173	Heister Cloverleaf Dairy	LSNR
PAG052206	Hartranft Service Station	LS8
PAG052223	Slusser Brothers, Inc. Panther Valley Middle School	LS11
PAR202240	Hart Metals	LS11
PAR602206	Joes Used Auto Parts	LS13
PA0070017	Barnesville STP	LS8
PA0070327	Eastern Diversified Metal (Superfund, zinc only metal of concern)	LS7
PAG122203	Heisler's Egg Farm	LSNR
PAG122206	Koch's Turkey Farm	LSNR
PA0070025	Rush-Ryan-Delano/Sewage	LS6
PA0038270	Sun Co. Inc. Tamaqua Market Terminal	LS9

Following is an example of how the allocations, presented in Table 10, for a stream segment are calculated. For this example, acidity allocations for LS7 of Little Schuylkill River are shown. As demonstrated in the example, all upstream contributing loads are accounted for at each point. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. These analyses follow the example. Attachment A contains maps of the sampling point locations for reference.

LS6	Acidity (Lbs/day)
Existing Load @ LS6	9397.50
Difference in measured Loads between upstream loads and existing LS6	4890.11
Percent loss due calculated at LS6	0%
Additional load tracked from above samples	332.33
Percentage of upstream loads that reach the LS6	100%
Total load tracked between LS5 and LS6	5222.44
Allowable Load @ LS6	751.74
Load Reduction @ LS6	4470.70
% Reduction required at LS6	86%

Load = 751.74lbs/day

Load input = 2862.36lb/day
(Difference between existing loads at LS7 and LS6)

LS7	Acidity (Lbs/day)
Existing Load @ LS7	12259.86
Difference in measured Loads between upstream loads and existing LS7	2862.36
Additional load tracked from above samples	751.74
Total load tracked between LS6 and LS7	3614.10
Allowable Load @ LS7	1359.95
Load Reduction @ LS7	2254.15
% Reduction required at LS7	62%

Load = 1359.95 lbs/day

The allowable load tracked from LS6 was 751.74 lbs/day. The existing load at LS6 was subtracted from the existing load at LS7 to show the actual measured increase of acidity load that has entered the stream between these two sample points (2862.36 lbs/day). This increased value was then added to the allowable load at LS6 to calculate the total load that was tracked between LS6 and LS7 (allowable load @ LS6 + the difference in existing load between LS6 and LS7). This total load tracked was then subtracted from the calculated allowable load at LS7 to determine the amount of load to be reduced at LS7. This value was found to be 3614.10 lbs/day; it was 2254.15 lbs/day greater than the LS7 allowable load of 1359.45 lbs/day. Therefore, a 62% reduction at LS7 is necessary. From this point, the allowable acidic load at LS7 will be tracked to the next downstream point, LS8.

Table 10. Little Schuylkill River Watershed Summary Table

Parameter	Existing Load (lbs/day)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Load Reduction (lbs/day)	% Reduction
LS1 – Little Schuylkill River at notched weir upstream of diversion wells						
Aluminum (lbs/day)	89.63	6.99	*0.14*	6.85	82.64	92%
Iron (lbs/day)	111.85	7.16	*0.14*	7.02	104.69	94%
Manganese(lbs/day)	22.98	9.24	*0.18*	9.06	13.74	60%
Acidity (lbs/day)	1176.94	5.36	0	5.36	1171.58	99.5%
LS2 – Silverbrook Outfall at weir upstream of diversion wells						
Aluminum (lbs/day)	107.86	6.54	*0.13*	6.41	101.32	94%
Iron (lbs/day)	307.30	19.98	*0.40*	19.58	287.32	93%
Manganese(lbs/day)	28.26	13.73	*0.27*	13.46	14.53	51%
Acidity (lbs/day)	2033.44	40.33	*0*	40.33	1993.11	98%
LS3 – Little Schuylkill River downstream of diversion wells and unnamed tributary						
Aluminum (lbs/day)	235.15	22.82	*0.46*	22.36	28.37	55%
Iron (lbs/day)	488.71	26.78	*0.54*	26.24	69.92	72%
Manganese(lbs/day)	62.27	31.87	*0.64*	31.23	2.13	6%
Acidity (lbs/day)	3112.52	159.77	0	159.77	0	0%*
LS4 – Lofty Creek near confluence with Little Schuylkill River						
Aluminum (lbs/day)	ND	NA	*0*	NA	NA	NA
Iron (lbs/day)	ND	NA	*0*	NA	NA	NA
Manganese(lbs/day)	3.83	3.83	*0.08*	3.75	NA	NA
Acidity (lbs/day)	1126.42	161.76	*0*	161.76	964.66	86%

Parameter	Existing Load (lbs/day)	TMDL	WLA	LA	Load	%
LS5 – Little Schuylkill River upstream of Northeastern Power Company						
Aluminum (lbs/day)	213.64	26.88	*0.54*	26.34	0	0%*
Iron (lbs/day)	338.14	38.88	*0.78*	38.10	0	0%*
Manganese(lbs/day)	59.84	35.87	*0.72*	35.15	0	0%*
Acidity (lbs/day)	4507.39	332.33	*0*	332.33	257.65	44%
LS6 – Little Schuylkill River downstream of Northeastern Power Company						
Aluminum (lbs/day)	397.66	61.93	*1.24*	60.69	148.97	71%
Iron (lbs/day)	522.21	104.84	3.21 = (1.11[△] + *2.10*)	101.63	118.11	53%
Manganese(lbs/day)	116.76	81.49	2.37 = (0.74[△] + *1.63*)	79.12	11.30	12%
Acidity (lbs/day)	9397.50	751.74	0	751.74	4470.70	86%
LS7 – Little Schuylkill River west of Hometown						
Aluminum (lbs/day)	102.75	33.65	7.01 = (6.34[#]+*0.67*)	26.64	0	0%*
Iron (lbs/day)	135.13	135.13	5.87 = (3.17[#]+*2.70*)	129.26	0	0%*
Manganese(lbs/day)	73.30	73.30	3.05 = (1.58[#]+*1.47*)	70.25	0	0%*
Acidity (lbs/day)	12259.86	1359.95	*0*	1359.95	2254.15	62%
LS8 – Little Schuylkill River downstream of Locust Creek						
Aluminum (lbs/day)	ND	NA	*0*	NA	NA	NA
Iron (lbs/day)	101.36	101.36	*2.03*	99.33	0	0%*
Manganese(lbs/day)	69.25	69.25	*1.39*	67.87	0	0%*
Acidity (lbs/day)	6585.65	889.82	*0*	889.82	0	0%*
LS9 – Little Schuylkill River at USGS gaging station at Tamaqua						
Aluminum (lbs/day)	ND	NA	*0*	NA	NA	NA
Iron (lbs/day)	195.72	195.72	*3.91*	191.81	0	0%*
Manganese(lbs/day)	41.57	41.57	*0.83*	40.74	0	0%*
Acidity (lbs/day)	2012.40	664.09	0	664.09	0	0%*
Panther Creek**						
Aluminum (lbs/day)	384.0	115.0	90.1***	24.9	---	---
Iron (lbs/day)	468.4	319.0	180.1***	138.9	---	---
Manganese(lbs/day)	444.3	178.0	168.0***	10.0	---	---
Acidity (lbs/day)	249.2	249.2	0	249.2	---	---
Wabash Creek**						
Aluminum (lbs/day)	46.3	6.0	0	6.0	---	---
Iron (lbs/day)	9.8	9.8	0	9.8	---	---
Manganese(lbs/day)	18.6	9.7	0	9.7	---	---
Acidity (lbs/day)	368.2	11.0	0	11.0	---	---

Parameter	Existing Load (lbs/day)	TMDL	WLA	LA	Load	%
LS11 – Little Schuylkill River 1.2 miles downstream from BET Associates - Route 309 Discharge						
Parameter	**Existing Load (lbs/day)**	**TMDL**	**WLA (lbs/day)**	**LA (lbs/day)**	**Load Reduction (lbs/day)**	**% Reduction**
Aluminum (lbs/day)	533.43	229.78	94.7 = (90.1*** + *4.6*)	135.08	0.00	0%*
Iron (lbs/day)	1830.06	451.36	189.1 = (180.1*** + *9.0*)	262.26	1229.3	73%
Manganese(lbs/day)	1116.09	254.40	173.1 = (168.0***+ *5.1*)	81.3	586.49	70%
Acidity (lbs/day)	12277.01	2035.23	-	2035.23	8536.27	81%
LSNR – Little Schuylkill River downstream of Route 443 bridge in New Ringgold						
Aluminum (lbs/day)	ND	NA	0	NA	NA	NA
Iron (lbs/day)	702.75	521.00	*10.4*	510.6	0.00	0%*
Manganese(lbs/day)	908.73	581.58	*11.6*	570.0	0.00	0%*
Acidity (lbs/day)	3150.25	351.37	*0*	351.37	170.86	33%
LS13 – Little Schuylkill River at mouth						
Aluminum (lbs/day)	897.46	528.86	*10.6*	518.26	368.60	41%
Iron (lbs/day)	801.31	544.89	*10.9*	533.99	74.67	12%
Manganese(lbs/day)	528.86	496.81	*9.9*	486.91	0	0%*
Acidity (lbs/day)	11987.56	2756.50	*0*	2756.50	6432.18	70%

* Total of loads affecting this segment is less than the allowable load calculated at this point based on mass balance of upstream loading, therefore no reduction is necessary.
** Independent TMDLs – refer to Panther Creek or Wabash Creek TMDL for more information
*** WLA assigned to BET Associates' operation with outfalls on Panther and Little Schuylkill, see explanation above
Δ WLA assigned to Mazaika Coal, one outfall 001 at LS6, see explanation above
\# WLA assigned to Tamaqua Area Water Authority – Still Creek WTP, one outfall 001 at LS7, see explanation above

ND = non detection NA = not applicable
Note – Italicized numbers = 2% Bulk Reserve WLA

Recommendations and Reasonable Assurance

Various methods to eliminate or treat pollutant sources and to provide a reasonable assurance that the proposed TMDLs can be met exist in Pennsylvania. These methods include PADEP's primary efforts to improve water quality through reclamation of abandoned mine lands (for abandoned mining) and through the National Pollution Discharge Elimination System (NPDES) permit program (for active mining). Funding sources available that are currently being used for projects designed to achieve TMDL reductions include the Environmental Protection Agency (EPA) 319 grant program and Pennsylvania's Growing Greener Program. Federal funding is through the Department the Interior, Office of Surface Mining (OSM), for reclamation and mine drainage treatment through the Appalachian Clean Streams Initiative and through Watershed Cooperative Agreements.

OSM reports that nationally, of the $8.5 billion of high priority (defined as priority 1&2 features or those that threaten public health and safety) coal related AML problems in the AML inventory, $6.6 billion (78%) have yet to be reclaimed; $3.6 billion of this total is attributable to Pennsylvania watershed costs. Almost 83 percent of the $2.3 billion of coal related environmental problems (priority 3) in the AML inventory are not reclaimed.

The Bureau of Abandoned Mine Reclamation, Pennsylvania's primary bureau in dealing with abandoned mine reclamation (AMR) issues, has established a comprehensive plan for abandoned mine reclamation throughout the Commonwealth to prioritize and guide reclamation efforts for throughout the state to make the best use of valuable funds (www.dep.state.pa.us/dep/deputate/minres/bamr/complan1.htm). In developing and implementing a comprehensive plan for abandoned mine reclamation, the resources (both human and financial) of the participants must be coordinated to insure cost-effective results. The following set of principles is intended to guide this decision making process:

- Partnerships between the DEP, watershed associations, local governments, environmental groups, other state agencies, federal agencies and other groups organized to reclaim abandoned mine lands are essential to achieving reclamation and abating acid mine drainage in an efficient and effective manner.

- Partnerships between AML interests and active mine operators are important and essential in reclaiming abandoned mine lands.

- Preferential consideration for the development of AML reclamation or AMD abatement projects will be given to watersheds or areas for which there is an approved rehabilitation plan. (guidance is given in Appendix B to the Comprehensive Plan).

- Preferential consideration for the use of designated reclamation moneys will be given to projects that have obtained other sources or means to partially fund the project or to projects that need the funds to match other sources of funds.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects where there are institutional arrangements for any necessary long-term operation and maintenance costs.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects that have the greatest worth.

- Preferential consideration for the development of AML projects will be given to AML problems that impact people over those that impact property.

- No plan is an absolute; occasional deviations are to be expected.

A detailed decision framework is included in the plan that outlines the basis for judging projects for funding, giving high priority to those projects whose cost/benefit ratios are most favorable and those in which stakeholder and landowner involvement is high and secure.

In addition to the abandoned mine reclamation program, regulatory programs also are assisting in the reclamation and restoration of Pennsylvania's land and water. PADEP has been effective in implementing the NPDES program for mining operations throughout the Commonwealth. This reclamation was done, through the use of remining permits which have the potential for reclaiming abandoned mine lands, at no cost to the Commonwealth or the federal government. Long-term treatment agreements were initialized for facilities/operators who need to assure treatment of post-mining discharges or discharges they degraded which will provide for long-term treatment of discharges. According to OSM, "PADEP is conducting a program where active mining sites are, with very few exceptions, in compliance with the approved regulatory program".

The Commonwealth is exploring all options to address its abandoned mine problem. During 2000-2006, many new approaches to mine reclamation and mine drainage remediation have been explored and projects funded to address problems in innovative ways. These include:

- Project XL - The Pennsylvania Department of Environmental Protection ("PADEP"), has proposed this XL Project to explore a new approach to encourage the remining and reclamation of abandoned coal mine sites. The approach would be based on compliance with in-stream pollutant concentration limits and implementation of best management practices ("BMPs"), instead of National Pollutant Discharge Elimination System ("NPDES") numeric effluent limitations measured at individual discharge points. This XL project would provide for a test of this approach in up to eight watersheds with significant acid mine drainage ("AMD") pollution. The project will collect data to compare in-stream pollutant concentrations versus the loading from individual discharge points and provide for the evaluation of the performance of BMPs and this alternate strategy in PADEP's efforts to address AMD.
- Awards of grants for 1) proposals with economic development or industrial application as their primary goal and which rely on recycled mine water and/or a site that has been made suitable for the location of a facility through the elimination of existing Priority 1 or 2 hazards, and 2) new and innovative mine drainage treatment technologies that will provide waters of higher purity that may be needed by a particular industry at costs below conventional treatment costs as in common use today or reduce the costs of water treatment below those of conventional lime treatment plants. Eight contracts totaling $4.075 M were awarded in 2006 under this program.

Two primary programs that provide reasonable assurance for maintenance and improvement of water quality in the watershed are in effect. The PADEP's efforts to reclaim abandoned mine lands, coupled with its duties and responsibilities for issuing NPDES permits, will be the focal points in water quality improvement.

Additional opportunities for water quality improvement are both ongoing and anticipated. Historically, a great deal of research into mine drainage has been conducted by PADEP's Bureau of Abandoned Mine Reclamation, which administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania, the United States Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and many other agencies and individuals. Funding from EPA's 319 Grant program, and Pennsylvania's Growing Greener program have been used extensively to remedy mine drainage impacts. These many activities are expected to continue and result in water quality improvement.

PA DEP must insure that BET completes its reclamation responsibilities at all the operations on which they have a legal responsibility for reclamation. In addition, the area would benefit from any PA Bureau of Abandoned Mine Projects or "Growing Greener" projects. The goal of these projects would be to stop AMD from forming and reduce the amount of AMD entering Panther Creek. Remediation may include, among other things, removal of abandoned highwalls, backfilling of abandoned pits, regarding and revegetation, and maintaining the deep mine pumps and treatment of mine pool water.

Abandoned highwall removal in conjunction with backfilling pits is recommended because these practices eliminate surface water accumulations. Such accumulations currently exhibit characteristics of AMD. An ancillary section of highwall removal is elimination of a safety hazard. Regrading and replanting abandoned areas is also recommended in the study area. The former may be in conjunction with highwall removal and backfilling of impoundment areas or it may involve old mined areas in which there are no abandoned highwalls. Regrading is beneficial by re-routing surface water and eliminating low areas in which surface water can impound. Replanting is a necessary follow-up to regrading. It aids in establishing reclaimed spoil and preventing silt and sedimentation from entering receiving streams.

The PA DEP will enforce all applicable coal mining laws and regulations to insure proper reclamation of all active mining areas that have been affected by the Lehigh Coal & Navigation Company. The reclamation of abandoned mine land features is dependent on Bureau of Abandoned Mine Land projects and "Growing Greener" projects

Candidate or federally-listed threatened and endangered species may occur in or near the watershed. While implementation of the TMDL should result in improvements to water quality, they could inadvertently destroy habitat for candidate or federally-listed species. TMDL implementation projects should be screened through the Pennsylvania Natural Diversity Inventory (PNDI) early in their planning process, in accordance with the Department's policy titled Policy for Pennsylvania Natural Diversity Inventory (PNDI) Coordination during Permit Review and Evaluation (Document ID# 400-0200-001).

Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on May 18, 2013 to foster public comment on the allowable loads calculated. Comments were received and are presented, along with Department responses to those comments, in Attachment J.

References

A.W. Martin Associates, Inc. for Pennsylvania Department of Environmental Resources. 1973. Little Schuylkill mine Drainage Pollution Abatement Project. Operation Scarlift.

Charles Taylor Associates. Interim Report on the Hydrologic Investigation of the Panther Valley Mine Pools in Schuylkill and Carbon Counties Pennsylvania. June 1988.

Daley, Timothy L. Unpublished. Cause/Effect Survey Panther Creek/Little Schuylkill River. Pennsylvania Department of Environmental Protection.

L. Robert Kimball & Associates for Schuylkill Conservation District. 2001. Little Schuylkill River Assessment Report.

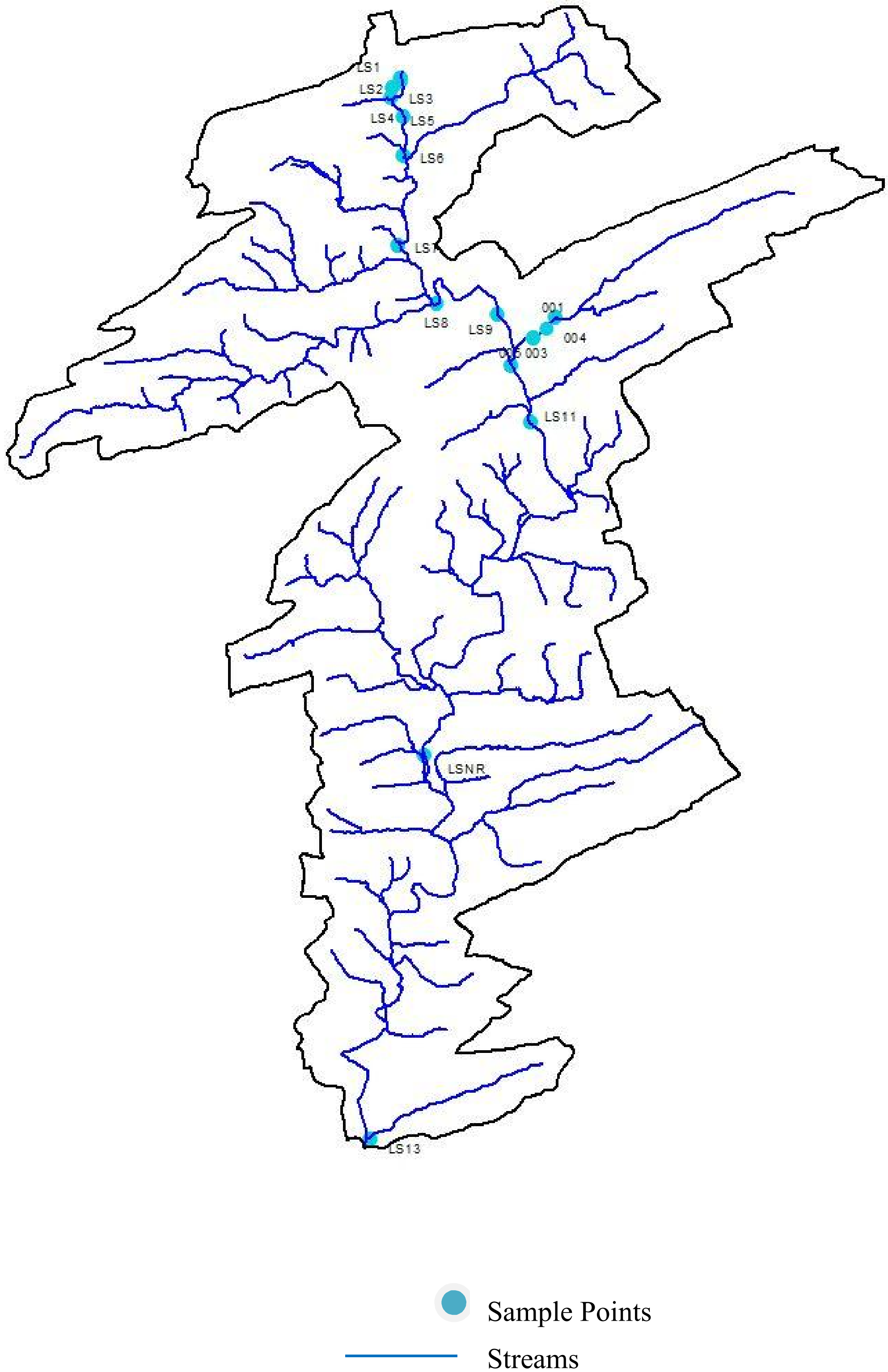
Pennsylvania Department of Environmental Protection, Revised Panther Creek Watershed TMDL, Schuylkill and Carbon Counties. June 2012.

Wood, Charles R. 1995. Water Quality of Large Discharges From Mines in the Anthracite Region of Eastern Pennsylvania. U.S. Geological Survey. Water-Resources Investigations Report 95-4243.

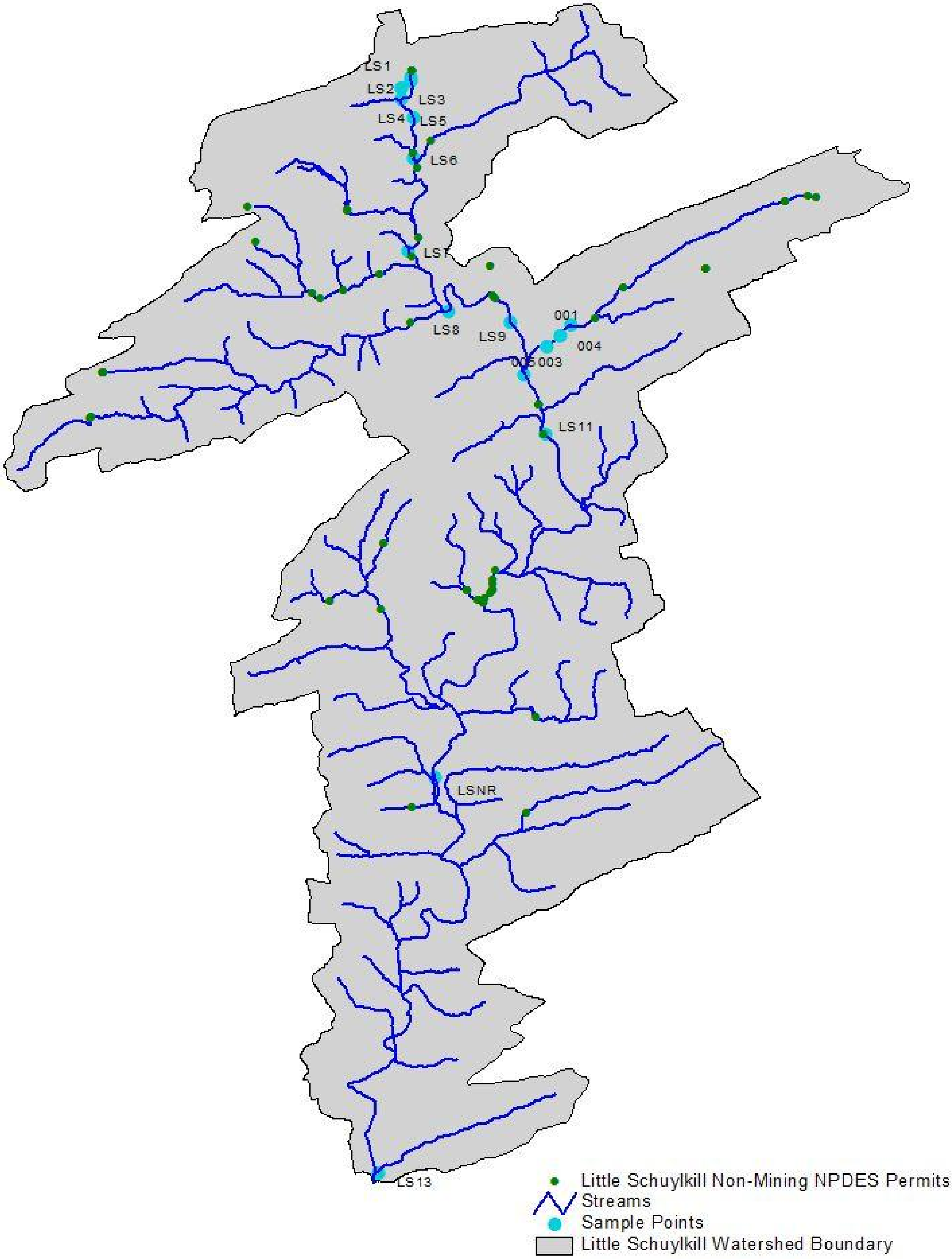
Attachment A

Little Schuylkill River Watershed Map

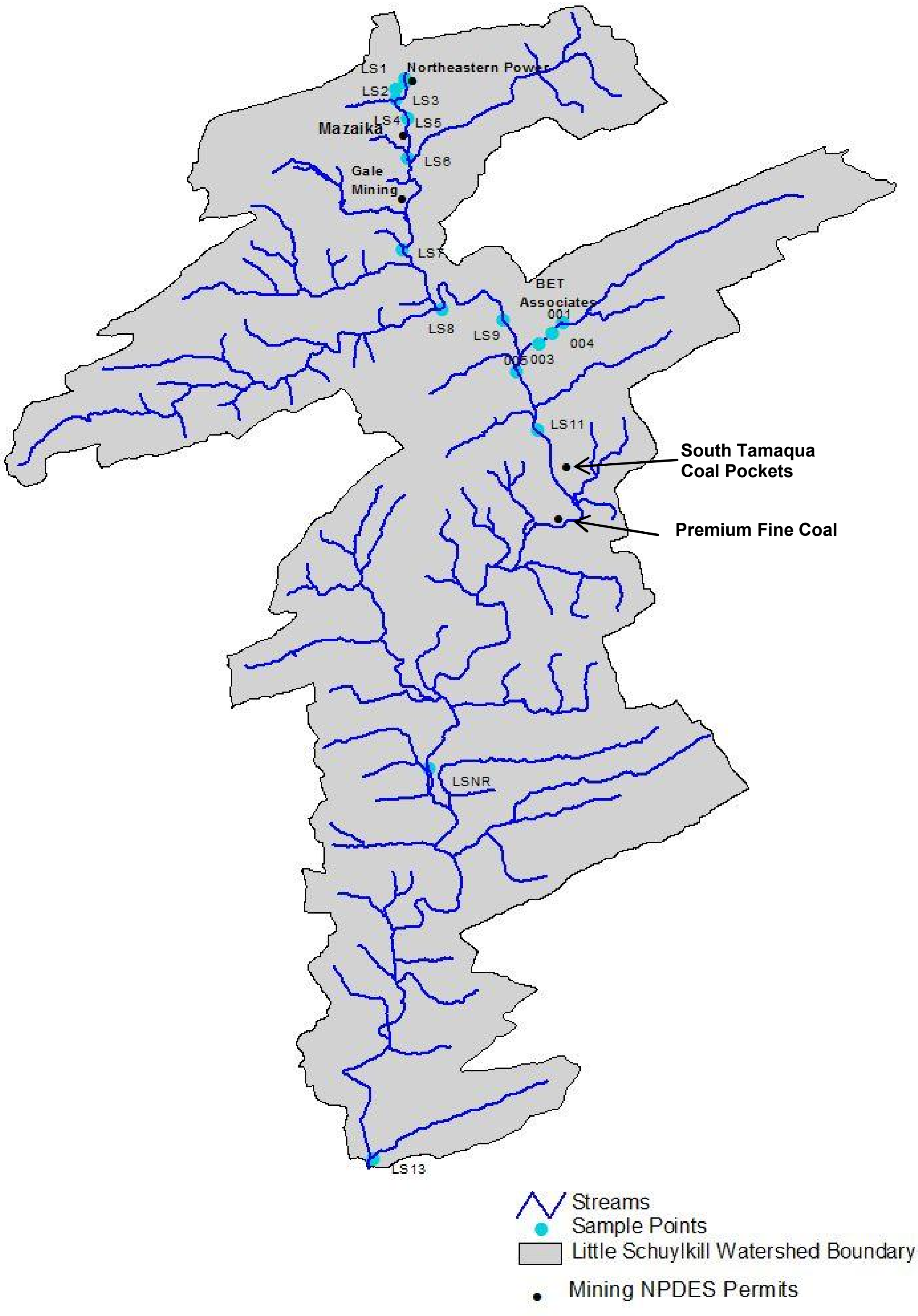
Little Schuylkill Watershed and Sample Points

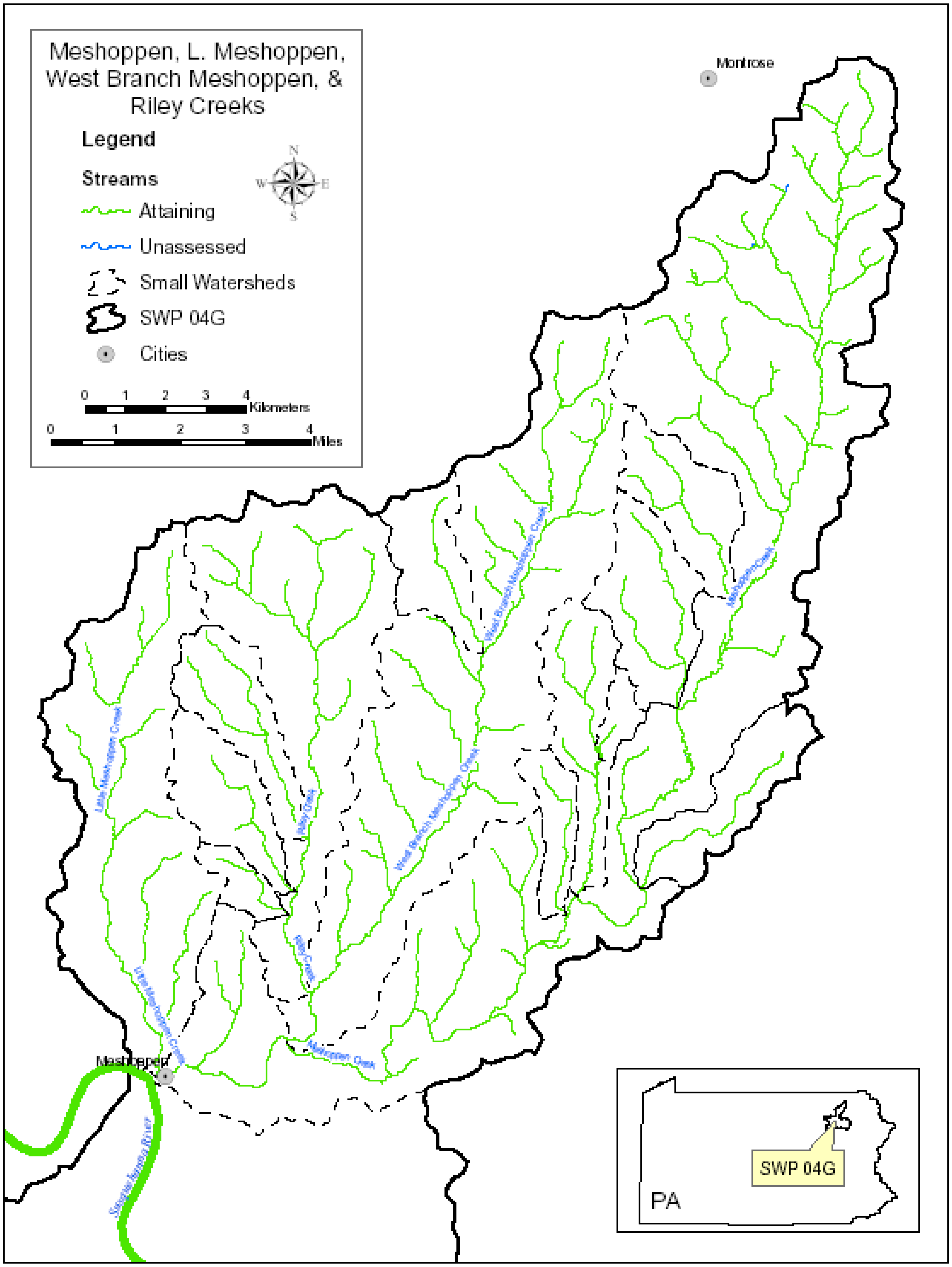


Little Schuylkill Watershed Sample Points and Non-Mining NPDES Permits



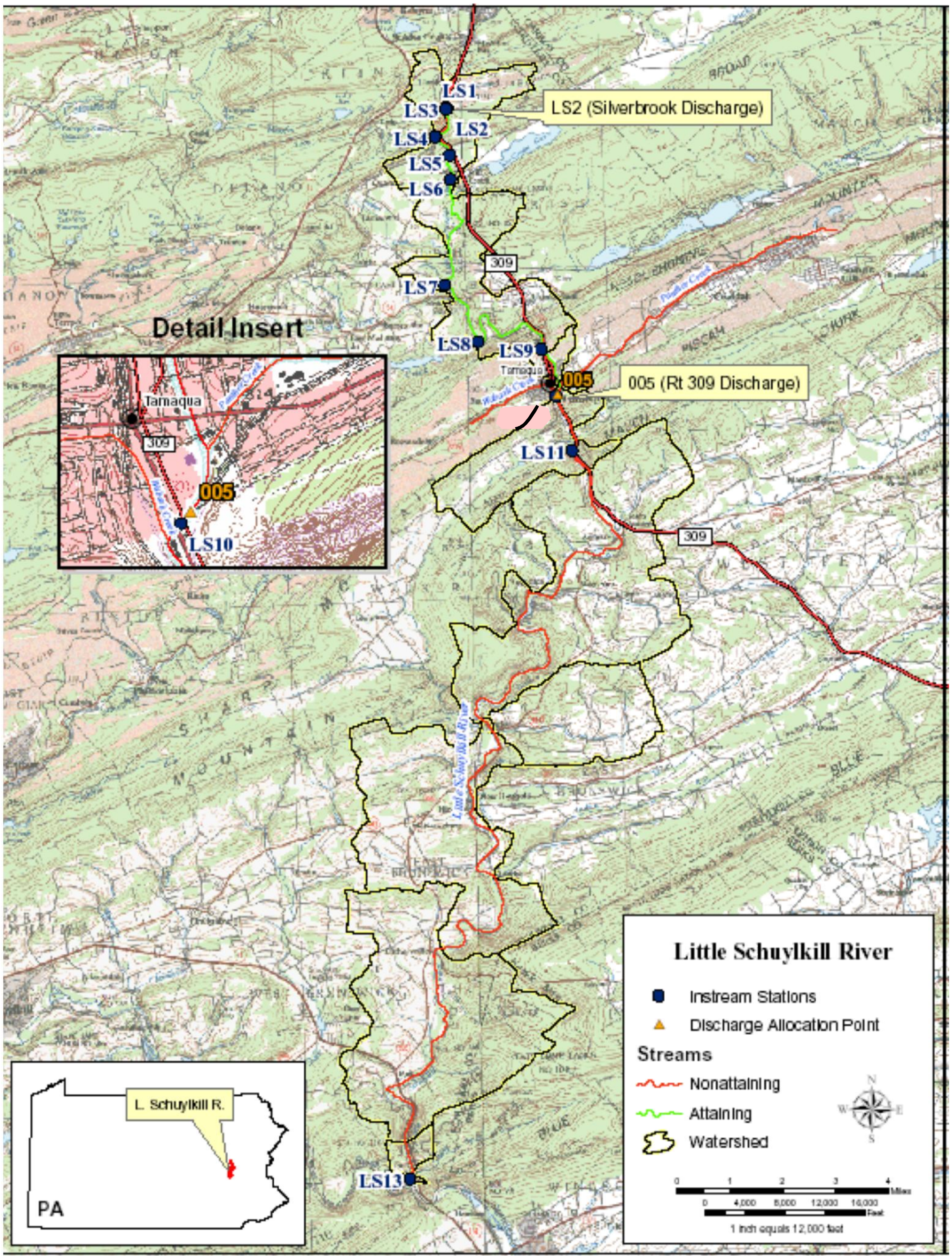
Little Schuylkill Sample Points and Mining NPDES Permits



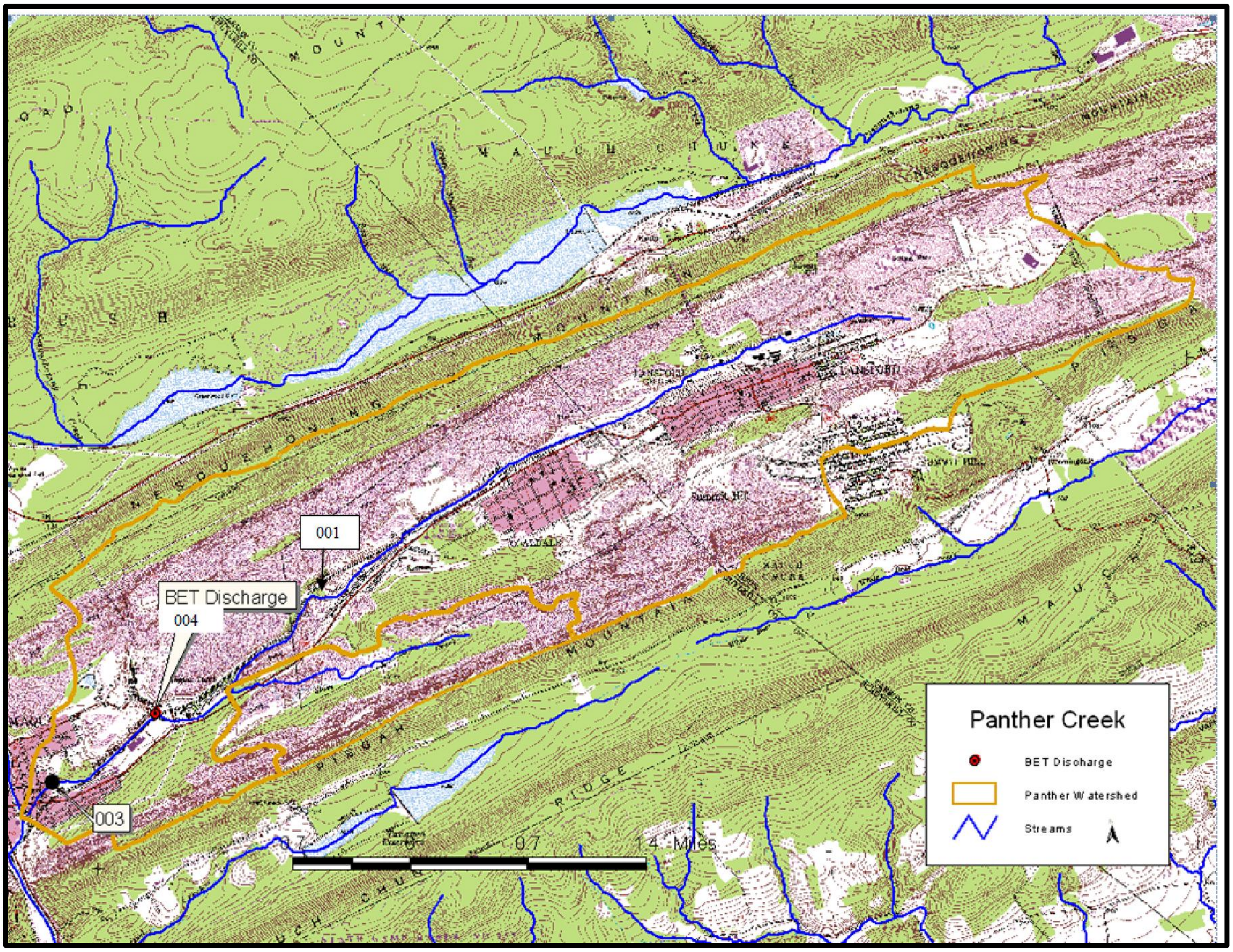


Meshoppen, L. Meshoppen, West Branch Meshoppen, & Riley Creeks
Legend
Streams
Attaining
Unassessed
Small Watersheds
SWP 04G
Cities
0 1 2 3 4 Kilometers
0 1 2 3 4 Miles
N
S
E
W
Montrose
Meshoppen
PA
SWP 04G

Location of Panther and Wabash Creeks within the Little Schuylkill Basin



BET Outfalls within Panther Creek Watershed



Attachment B

Method for Addressing Section 303(d) Listings for pH and *Surface Mining Control and Reclamation Act*

Method for Addressing Section 303(d) Listings for pH

There has been a great deal of research conducted on the relationship between alkalinity, acidity, and pH. Research published by the Pa. Department of Environmental Protection demonstrates that by plotting net alkalinity (alkalinity-acidity) vs. pH for 794 mine sample points, the resulting pH value from a sample possessing a net alkalinity of zero is approximately equal to six (Figure 1). Where net alkalinity is positive (greater than or equal to zero), the pH range is most commonly six to eight, which is within the EPA's acceptable range of six to nine and meets Pennsylvania water quality criteria in Chapter 93.

The pH, a measurement of hydrogen ion acidity presented as a negative logarithm, is not conducive to standard statistics. Additionally, pH does not measure latent acidity. For this reason, and based on the above information, Pennsylvania is using the following approach to address the stream impairments noted on the Section 303(d) list due to pH. The concentration of acidity in a stream is at least partially chemically dependent upon metals. For this reason, it is extremely difficult to predict the exact pH values, which would result from treatment of abandoned mine drainage. Therefore, net alkalinity will be used to evaluate pH in these TMDL calculations. This methodology assures that the standard for pH will be met because net alkalinity is a measure of the reduction of acidity. When acidity in a stream is neutralized or is restored to natural levels, pH will be acceptable. Therefore, the measured instream alkalinity at the point of evaluation in the stream will serve as the goal for reducing total acidity at that point. The methodology that is applied for alkalinity (and therefore pH) is the same as that used for other parameters such as iron, aluminum, and manganese that have numeric water quality criteria.

Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Net alkalinity is alkalinity minus acidity, both being in units of milligrams per liter (mg/l) $CaCO_3$. The same statistical procedures that have been described for use in the evaluation of the metals is applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for mine waters is not a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

There are several documented cases of streams in Pennsylvania having a natural background pH below six. If the natural pH of a stream on the Section 303(d) list can be established from its upper unaffected regions, then the pH standard will be expanded to include this natural range. The acceptable net alkalinity of the stream after treatment/abatement in its polluted segment will be the average net alkalinity established from the stream's upper, pristine reaches added to the acidity of the polluted portion in question. Summarized, if the pH in an unaffected portion of a stream is found to be naturally occurring below six, then the average net alkalinity for that portion (added to the acidity of the polluted portion) of the stream will become the criterion for the polluted portion. This "natural net alkalinity level" will be the criterion to which a 99 percent confidence level will be applied. The pH range will be varied only for streams in which a natural unaffected net alkalinity level can be established. This can only be done for streams that have upper segments that are not impacted by mining activity. All other streams will be required to reduce the acid load so the net alkalinity is greater than zero 99% of time.

Reference: *Rose, Arthur W. and Charles A. Cravotta, III 1998. Geochemistry of Coal Mine Drainage. Chapter 1 in Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania. Pa. Dept. of Environmental Protection, Harrisburg, Pa.*

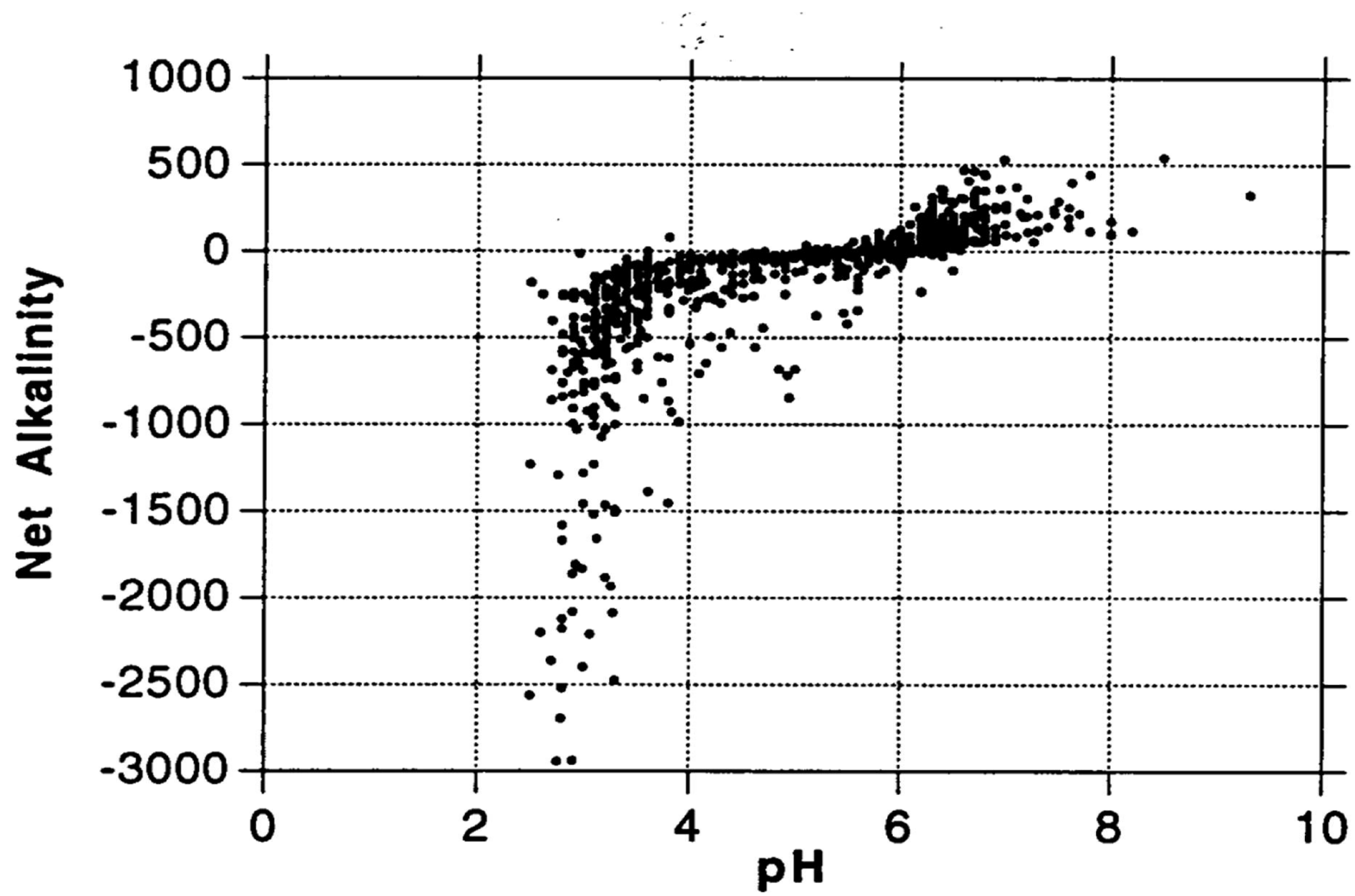


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Attachment C
TMDLs By Segment

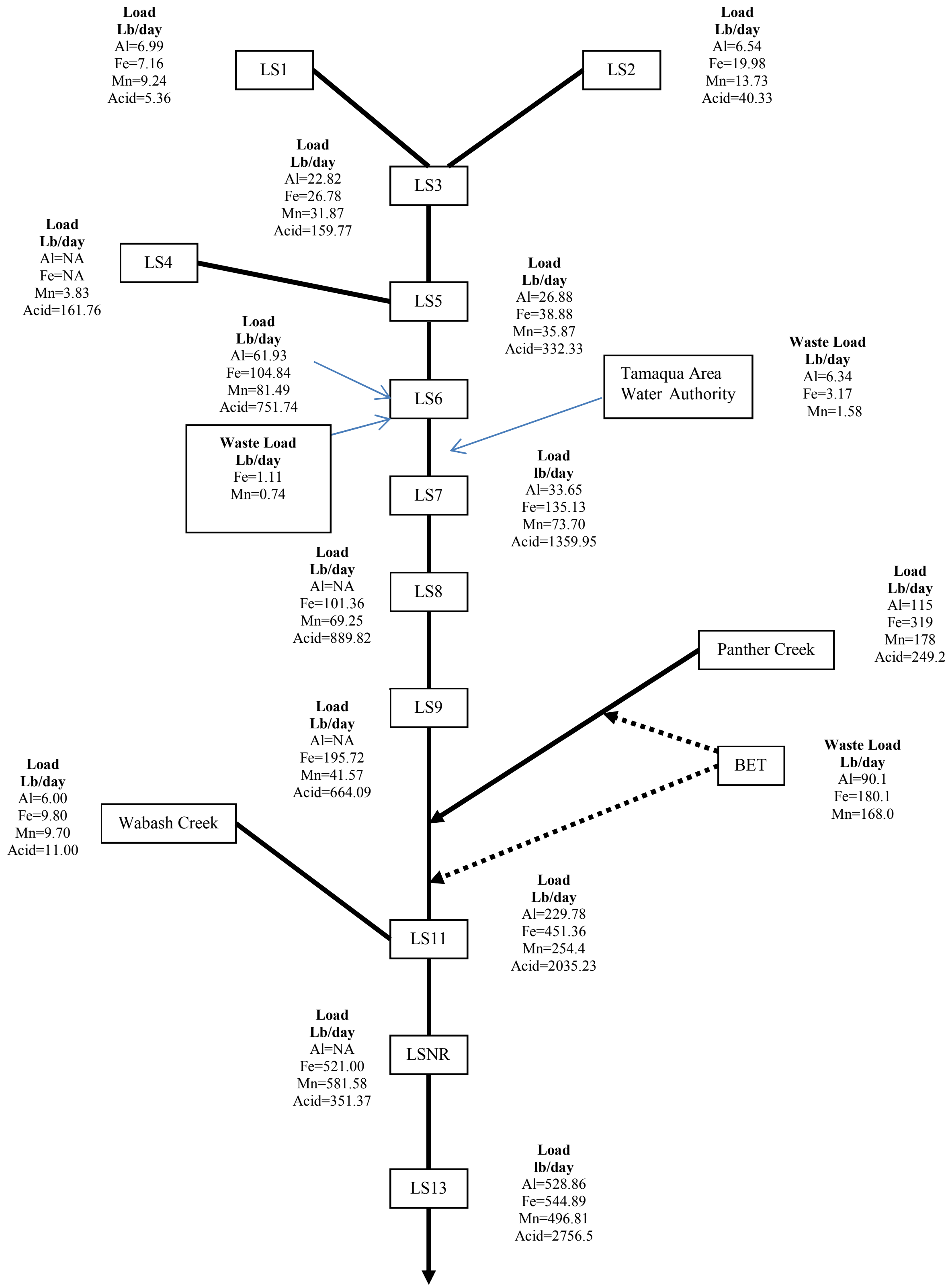
Little Schuylkill River

The Little Schuylkill River is a cold-water fishery (CWF) that flows into the Schuylkill River. Little Schuylkill River (stream code 02202) is identified as Segment 6189 under State Water Plan 3-A. A total of 12 sample locations (LS1 – LS9, LS11, LSNR, LS13) were identified in the initial assessment of the Little Schuylkill River. Eleven sampling sites on the Little Schuylkill, one site on Lofty Creek (LS4), one discharge (LS2) and two previous TMDLs (Panther and Wabash Creeks) were included in Little Schuylkill calculations.

Data sets include multiple rounds of water quality sampling. The Little Schuylkill River is too large of a waterway to correctly and safely collect flow measurements at the most downstream points. The available flow data did not correctly represent the existing flow dynamics of the Little Schuylkill River. In order to achieve a relative representation of the true flow characteristics, the unit area method was used based on watershed area and flow at the U.S. Geological Survey stream gauge on the Little Schuylkill River at Tamaqua (#01469500). All sample points are shown on the maps included in Attachment A as well as on the loading schematic on the following page.

Little Schuylkill River is listed as impaired on the 1996 PA Section 303(d) list for metals, suspended solids, and depressed pH from AMD. Although this TMDL will focus primarily on metals, pH and reduced acid loading will be performed as well. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range and keep a net alkalinity above zero, 99% of the time. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see TMDL Endpoint section in the report, Table 2). The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at each sample point for metals and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Following is an explanation of the TMDL for each allocation point.


Load
Lb/day
Al=6.99
Fe=7.16
Mn=9.24
Acid=5.36
LS1
LS2
Load
Lb/day
Al=6.54
Fe=19.98
Mn=13.73
Acid=40.33
Load
Lb/day
Al=22.82
Fe=26.78
Mn=31.87
Acid=159.77
LS3
Load
Lb/day
Al=NA
Fe=NA
Mn=3.83
Acid=161.76
LS4
LS5
Load
Lb/day
Al=26.88
Fe=38.88
Mn=35.87
Acid=332.33
Load
Lb/day
Al=61.93
Fe=104.84
Mn=81.49
Acid=751.74
LS6
Tamaqua Area Water Authority
Waste Load
Lb/day
Al=6.34
Fe=3.17
Mn=1.58
Waste Load
Lb/day
Fe=1.11
Mn=0.74
LS7
Load
lb/day
Al=33.65
Fe=135.13
Mn=73.70
Acid=1359.95
Load
Lb/day
Al=NA
Fe=101.36
Mn=69.25
Acid=889.82
LS8
Panther Creek
Load
Lb/day
Al=115
Fe=319
Mn=178
Acid=249.2
LS9
Load
Lb/day
Al=NA
Fe=195.72
Mn=41.57
Acid=664.09
BET
Waste Load
Lb/day
Al=90.1
Fe=180.1
Mn=168.0
Load
Lb/day
Al=6.00
Fe=9.80
Mn=9.70
Acid=11.00
Wabash Creek
Load
Lb/day
Al=229.78
Fe=451.36
Mn=254.4
Acid=2035.23
LS11
Load
Lb/day
Al=NA
Fe=521.00
Mn=581.58
Acid=351.37
LSNR
LS13
Load
lb/day
Al=528.86
Fe=544.89
Mn=496.81
Acid=2756.5

TMDL calculations- LS1 – notched weir on Little Schuylkill River, upstream of diversion wells

The TMDL for sample point LS1 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this headwaters segment of the Little Schuylkill River was computed using water-quality sample data collected at point LS1. The average flow, calculated using the unit method at sampling point LS1 (2.16 MGD), is used for these computations. Because this is the most upstream point of this segment, the allowable load allocations calculated at LS1 is equal to the actual load that will directly affect the downstream point LS3.

Sample data at point LS1 shows that the headwaters segment has a pH ranging between 3.7 and 4.2. There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH.

A TMDL for aluminum, iron, manganese and acidity at LS1 has been calculated. Table C1 shows the measured and allowable concentrations and loads at LS1. Table C2 shows percent reductions for aluminum, iron, manganese and acidity required at this point.

Table C1		Measured		Allowable	
Flow (gpm)=	1500	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	4.98	89.63	0.39	6.99
	Iron	6.21	111.85	0.40	7.16
	Manganese	1.28	22.98	0.51	9.24
	Acidity	65.33	1176.94	0.30	5.36
	Alkalinity	0.51	9.21		

TABLE C2. ALLOCATIONS LS1				
LS1	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS1	89.63	111.85	22.98	1176.94
Allowable Load @ LS1	6.99	7.16	9.24	5.36
Load Reduction @ LS1	82.64	104.69	13.74	1171.58
% Reduction required @ LS1	92%	94%	60%	99.5%

TMDL Calculation – LS2 – notched weir @ Silverbrook outflow, upstream of diversion wells

The TMDL for sample point LS2 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this upper segment of Little Schuylkill River was computed using water-quality sample data collected at point LS2. The average flow, calculated using the unit area method at sampling point LS2 (2.16 MGD), is used for these computations. Because this an upstream point of this segment, the allowable load allocations calculated at LS2 is equal to the actual load that will directly affect the downstream point LS3.

Sample data at point LS2 shows a pH ranging between 3.7 and 4.4. There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH.

A TMDL for aluminum, iron, manganese and acidity at LS2 have been calculated. Table C3 shows the measured and allowable concentrations and loads at LS2. Table C4 shows percent reductions for aluminum, iron, manganese and acidity required at this point.

Table C3		Measured		Allowable	
Flow (gpm)=	1500	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	5.99	107.86	0.36	6.54
	Iron	17.06	307.30	1.11	19.98
	Manganese	1.57	28.26	0.76	13.73
	Acidity	112.88	2033.44	2.24	40.33
	Alkalinity	0.96	17.25		

Table C4. Allocations LS2				
LS2	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS2	107.86	307.30	28.26	2033.44
Allowable Load @ LS2	6.54	19.98	13.73	40.33
Load Reduction @ LS2	101.32	287.32	14.53	1993.11
% Reduction required @ LS2	94%	93%	51%	98%

TMDL Calculation – LS3 – downstream of diversion wells and a small-unnamed tributary

The TMDL for sampling point LS3 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point LS3. The average flow, calculated using the unit area method at sampling point LS3 (5.76 MGD), is used for these computations. The allowable loads calculated at LS3 will directly affect the downstream point LS5.

Sample data at point LS3 shows pH ranging between 3.9 and 6.0; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

The measured and allowable loading for point LS3 for aluminum, iron, manganese and acidity was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The additional load from points LS1 and LS2 show the total load that was permitted from upstream sources. This value was added to the difference in existing loads between point LS1/LS2 and LS3 to determine a total load tracked for the segment of stream between LS3 and

LS2/LS1. This load will be compared to the allowable load to determine if further reductions are needed to meet the calculated TMDL at LS3.

A TMDL for aluminum, iron, manganese and acidity at LS3 has been calculated. Table C5 shows the measured and allowable concentrations and loads at LS3. Table C6 shows the percent reduction needed for these parameters at this point.

Table C5		Measured		Allowable	
Flow (gpm)=	3999.53	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	4.90	235.15	0.48	22.82
	Iron	10.17	488.71	0.56	26.78
	Manganese	1.30	62.27	0.66	31.87
	Acidity	64.80	3112.52	3.33	159.77
	Alkalinity	5.31	255.11		

Table C6. Allocations LS3				
LS3	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS3	235.15	488.71	62.27	3112.52
Difference in measured Loads between upstream loads and existing LS3	37.66	69.56	11.03	-97.86
Percent loss calculated at LS3	0%	0%	0%	3%
Additional load tracked from above samples	13.53	27.14	22.97	45.69
Percentage of upstream loads that reach LS3	100%	100%	100%	97%
Total load tracked between LS2/LS1 and LS3	51.19	96.70	34.00	44.30
Allowable Load @ LS3	22.82	26.78	31.87	159.77
Load Reduction @ LS3	28.37	69.92	2.13	0
% Reduction required at LS3	55%	72%	6%	0%

The existing aluminum load at LS3 was measured to be 235.15 lbs/day. This was 37.66 lbs/day greater than the upstream contributing loads. This increase in aluminum load in this segment can be attributed to aluminum entering the river in this segment. The total aluminum load tracked was 28.37 lbs/day greater than the calculated allowable aluminum load of 22.82 lbs/day; therefore a 55% reduction for aluminum is necessary. The existing iron load was reported to be 488.71 lbs/day. An increase of 69.56 lbs/day of iron has entered the Little Schuylkill River between LS1/LS2 and LS3. The total iron load tracked was found to be 69.92 lbs/day greater than the calculated allowable iron load of 26.78 lbs. A 72% reduction is required for iron. The Little Schuylkill River has gained 11.03 lbs/day of manganese by the time it reaches sample point LS3. The total load tracked was 2.13 lbs/day greater than the allowable load of 31.87 lbs/day; therefore a 6% manganese reduction is necessary. The acidic load at LS3 of 44.30 lbs/day was less is than the allowable acidic load at LS3 of 159.77 lbs/day; therefore, no reduction in acidity at LS3 is necessary.

TMDL Calculation – LS4 – Lofty Creek, just upstream of confluence with Little Schuylkill

The TMDL for sample point LS4 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this tributary of the Little Schuylkill River was computed using water-quality sample data collected at point LS4. The average flow, calculated using the unit area method at sampling point LS4 (6.47 MGD), is used for these computations. Because this a tributary point, the allowable load allocations calculated at LS4 is equal to the actual load that will directly affect the downstream point LS5.

Sample data at point LS4 shows a pH ranging between 4.8 and 5.8. There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH.

A TMDL for acidity at LS4 have been calculated. All measured sample data for aluminum and iron fell below the detection limits. The measured sample data at manganese was above detection limits but fell below applicable water quality criteria limits. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated. The existing load for aluminum and iron values at LS4 in Table C7 will be denoted as "NA".

Table C7 shows the measured and allowable concentrations and loads at LS4. Table C8 shows percent reductions for acidity required at this point.

Table C7		Measured		Allowable	
Flow (gpm)=	4494.88	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	ND	NA		
	Iron	ND	NA		
	Manganese	0.07	3.83	0.07	3.83
ND = non detection	Acidity	20.87	1126.42	3.00	161.76
NA = not applicable	Alkalinity	6.69	361.08		

Table C8. Allocations LS4		
LS4	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS4	3.83	1126.42
Allowable Load @ LS4	3.83	161.76
Load Reduction @ LS4	0	964.66
% Reduction required @LS4	0	86%

TMDL Calculation – LS5 – upstream of Northeast Power Company

The TMDL for sampling point LS5 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point LS5. The average flow, calculated using the unit area method for LS5 (11.56 MGD), is used for these computations. The allowable loads calculated at LS5 will directly affect the downstream point LS6.

Sample data at point LS5 shows pH ranging between 4.3 and 4.8; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

The measured and allowable loading for point LS5 for aluminum, iron, manganese and acidity was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The additional load from points LS3 and LS4 show the total load that was permitted from upstream sources. This value was added to the difference in existing loads between point LS3/LS4 and LS5 to determine a total load tracked for the segment of stream between LS5 and LS3/LS4. This load will be compared to the allowable load to determine if further reductions are needed to meet the calculated TMDL at LS5.

A TMDL for aluminum, iron, manganese and acidity at LS5 has been calculated. Table C9 shows the measured and allowable concentrations and loads at LS5. Table C10 shows the percent reduction needed for these parameters at this point.

Table C9		Measured		Allowable	
Flow (gpm)=	8028.14	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	2.22	213.64	0.28	26.88
	Iron	3.51	338.14	0.40	38.88
	Manganese	0.62	59.84	0.37	35.87
	Acidity	46.75	4507.39	3.45	332.33
	Alkalinity	5.75	554.38		

Table C10. Allocations LS5				
LS5	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS5	213.64	338.14	59.84	4507.39
Difference in measured Loads between upstream loads and existing LS5	-21.51	-150.57	-6.26	268.45
Percent loss due calculated at LS5	9%	31%	9%	0%
Additional load tracked from above samples	22.82	26.78	35.70	321.53
Percentage of upstream loads that reach the LS5	91%	69%	91%	100%
Total load tracked between LS3/LS4 and LS5	20.73	18.53	32.32	589.98
Allowable Load @ LS5	26.88	38.88	35.87	332.33
Load Reduction @ LS5	0	0	0	257.65
% Reduction required at LS5	0%	0%	0%	44%

Sample data for aluminum, iron and manganese all show that the load tracked from upstream points (LS3/LS4) is lower than the allowable load at LS5; therefore, no reductions are necessary at LS5. Acidity called for a 44% reduction to achieve the allowable load of 332.33 lbs/day.

TMDL Calculation – LS6– Little Schuylkill River downstream of Northeast Power Company

The TMDL for sampling point LS6 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point LS6. The average flow, calculated using the unit area method for LS6 (24.66 MGD), is used for these computations. The allowable load allocations calculated at LS6 will directly affect the downstream point LS7.

Sample data at point LS6 shows pH ranging between 4.4 and 4.8; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

The measured and allowable loading for point LS6 for all parameters was computed using water-quality sample data collected at this point. This was based on the sample data for this point and did not account for any loads already specified from upstream sources. The existing load for each parameter from point LS5 was subtracted from the actual load at point LS6 to determine a remaining load that was added to the allowable load from LS5 to determine the total load for the segment of stream between LS5 and LS6. This total load will be compared to the calculated allowable load at LS6 to determine if further reductions are needed to meet the calculated TMDL at LS6.

Waste Load Allocation – Outfalls 001, Mazaika Coal Discharge to LS6

Mazaika Coal Company (SMP 54840209R5 C3 & AR2010, NPDES PA0224804) has one outfall located between sampling points LS5 and LS6. The Waste Load Allocation associated with Mazaika Coal's permit is determined using flow calculated for one outfall from two standard pits and existing permit limits for Fe and Mn, reasonable potential analysis showed Al not to be a pollutant of concern. The following table shows the waste load allocation for this discharge.

Table C11. Mazaika Coal Company Waste Load Allocations at Outfall 001		
Parameter	Average Flow (MGD)	Allowable Load (lbs/day)
Outfall 001		
Fe	0.0445	1.11
Mn**	0.0445	0.74

A TMDL for aluminum, iron, manganese and acidity at LS6 have been calculated. Table C12 shows the measured and allowable concentrations and loads at LS6. Table C13 shows the percent reduction for aluminum, iron, manganese and acidity needed at LS6.

Table C12		Measured		Allowable	
Flow (gpm)=	17126.68	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	1.93	397.66	0.30	61.93
	Iron	2.54	522.21	0.51	104.84
	Manganese	0.57	116.76	0.40	81.49
	Acidity	45.69	9397.50	3.65	751.74
	Alkalinity	5.93	1220.40		

Table C13. Allocations LS6				
LS6	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS6	397.66	522.21	116.76	9397.50
Difference in measured Loads between upstream loads and existing LS6	184.02	184.07	56.92	4890.11
Percent loss due calculated at LS6	0%	0%	0%	0%
Additional load tracked from above samples	26.88	38.88	35.87	332.33
Percentage of upstream loads that reach the LS6	100%	100%	100%	100%
Total load tracked between LS5 and LS6	210.90	222.95	92.79	5222.44
Allowable Load @ LS6	61.93	104.84	81.49	751.74
Load Reduction @ LS6	148.97	118.11	11.30	4470.70
% Reduction required at LS6	71%	53%	12%	86%

The existing aluminum load at LS6 was measured to be 397.66 lbs/day. This was 184.02 lbs/day greater than the upstream contributing loads. This increase in aluminum load in this segment can be attributed to aluminum entering the river in this segment. The total aluminum load tracked was 148.97 lbs/day greater than the calculated allowable aluminum load of 61.93 lbs/day; therefore a 71% reduction for aluminum is necessary. The existing iron load was reported to be 522.21 lbs/day. An increase of 184.07 lbs/day of iron has entered the Little Schuylkill River between LS5 and LS6. The total iron load tracked was found to be 222.95 lbs/day greater than the calculated allowable iron load of 104.84 lbs. A 53% reduction is required for iron. The Little Schuylkill River has gained 56.92 lbs/day of manganese by the time it reaches sample point LS6. The total load tracked was 11.30 lbs/day greater than the allowable load of 81.49 lbs/day; therefore a 13% manganese reduction is necessary. The Little Schuylkill River has gained 4890.11 lbs/day of acidity by the time it reaches sample point LS6. The total load tracked was 4470.70 lbs/day greater than the allowable load of 751.74 lbs/day; therefore an 86% acidity reduction is necessary.

TMDL Calculation – LS7 – Little Schuylkill River west of Hometown

The TMDL for sampling point LS7 on the Little Schuylkill River consists of a load allocation of the entire area above point LS7 as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point LS7. The average flow, using a ratio method at LS7 (31.37 MGD), is used for these computations. The allowable load calculated at LS7 will directly affect the downstream point LS8.

There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point LS7 shows pH ranging between 5.0 and 6.1; pH will be addressed as part of this TMDL.

The measured and allowable loading for point LS7 for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The existing load for each parameter from point LS6 was subtracted from the actual load at point LS7 to determine a remaining load that was added to the allowable load from LS6 to calculate the total load for the segment of stream between LS6 and LS7. This total load will be compared to the calculated allowable load at LS7 to determine if further reductions are needed to meet the calculated TMDL at LS7.

A TMDL for aluminum and acidity at LS7 has been calculated. The measured sample data for iron and manganese were above detection limits but fell below applicable water quality criteria limits. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated.

Waste Load Allocation – Outfall 001, PA0063053, Tamaqua Area Water Authority – Still Creek WTP - Discharge to LS7

Tamaqua Area Water Authority – Still Creek WTP (NPDES PA0063053) has one outfall located between sampling points LS6 and LS7. The Waste Load Allocation associated with the permit is determined using the plant's design flow and existing permit limits for Al, Fe and Mn. The following table shows the waste load allocation for this discharge.

Table C11. Tamaqua Area Water Authority – Still Creek WTP Waste Load Allocations

Parameter	Design Flow (MGD)	Allowable Load (lbs/day)
Al	0.19	6.34
Fe	0.19	3.17
Mn	0.19	1.58

Table C14 shows the measured and allowable concentrations and loads at LS7. Table C15 shows the percent reductions required for aluminum and acidity at sample point LS7.

Table C14		Measured		Allowable	
Flow (gpm)=	21781.75	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	0.39	102.75	0.13	33.65
	Iron	0.52	135.13	0.52	135.13
	Manganese	0.28	73.30	0.28	73.30
	Acidity	46.87	12259.86	5.20	1359.95
	Alkalinity	8.11	2121.79		

Table C15. Allocations LS7		
LS7	Al (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS7	102.75	12259.86
Difference in measured Loads between upstream loads and existing LS7	-294.91	2862.36
Percent loss due calculated at LS7	74%	0%
Additional load tracked from above samples	61.93	751.74
Percentage of upstream loads that reach the LS7	26%	100%
Total load tracked between LS6 and LS7	16.00	3614.10
Allowable Load @ LS7	33.65	1359.95
Load Reduction @ LS7	0	2254.15
% Reduction required at LS7	0%	62%

The sample data collected at LS7 show water quality standards for iron and manganese are being met; therefore, no reductions are necessary for these pollutants at LS7. No reductions in aluminum are necessary because the total load tracked between LS6 and LS7 is lower than the allowable load of 33.65 lbs/day at LS7. The sample data show an increase in acidity load between LS6 and LS7 of 2862.36 lbs/day which results in the acid load at LS7 being greater than the allowable load of 1359.95 lbs/day by 2254.15 lbs/day, requiring a 62% reduction in acidity.

TMDL Calculation – LS8 – downstream of Locust Creek

The TMDL for sampling point LS8 on the Little Schuylkill River consists of a load allocation of the entire area above point LS8 as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point LS8. The average flow, using the unit area method at LS8 (56.20 MGD), is used for these computations. The allowable loads calculated at LS8 will directly affect the downstream point LS9.

There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point LS8 shows pH ranging between 5.8 and 7.1; pH will be addressed as part of this TMDL.

The measured and allowable loading for point LS8 for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The existing load for each parameter from point LS7 was subtracted from the existing load at point LS8 to determine a remaining load that was then added to the allowable load from LS7 to calculate the total load for the segment of stream between LS7 and LS8. This total load will be compared to the calculated allowable load at LS8 to determine if further reductions are needed to meet the calculated TMDL at LS8.

A TMDL for acidity at LS8 has been calculated. All measured sample data for aluminum fell below detection limits. The measured sample data for iron and manganese were above detection limits but fell below applicable water quality criteria limits. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated. The existing load for aluminum values at LS8 in Table C15 will be denoted as "NA".

Table C16 shows the measured and allowable concentrations and loads at LS8. Table C17 shows the percent reduction required for acidity at sample point LS8.

Table C16		Measured		Allowable	
Flow (gpm)=	39029.57	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	ND	NA		
	Iron	0.22	101.36	0.22	101.36
	Manganese	0.15	69.25	0.15	69.25
ND = non detection	Acidity	14.05	6585.65	1.90	889.82
NA = not applicable	Alkalinity	12.30	5765.37		

Table C17. Allocations LS8	
LS8	Acidity (Lbs/day)
Existing Load @ LS8	6585.65
Difference in measured Loads between upstream loads and existing LS8	-5674.21
Percent loss due calculated at LS8	46%
Additional load tracked from above samples	1359.95
Percentage of upstream loads that reach the LS8	54%
Total load tracked between LS7 and LS8	730.53
Allowable Load @ LS8	889.82
Load Reduction @ LS8	0
% Reduction required at LS8	0%

The existing acidic load was measured at 6585.65 lbs/day. This was less than the existing load of the upstream point LS7, meaning that 5674.21 lbs/day, or 46%, had been lost to instream processes in the segment between upstream point LS7 and LS8. The total acidic load tracked between LS7 and LS8 was found to be less than the calculated acidic allowable load of 889.82 lbs/day at LS8. Therefore, no acidic reduction at sample point LS8 is necessary. Water quality standards for aluminum, iron, and manganese are being met at LS8 and therefore no reductions are necessary.

TMDL Calculation – LS9 – USGS gauging station on Little Schuylkill River at Tamaqua

The TMDL for sampling point LS9 on the Little Schuylkill River consists of a load allocation of the entire area above point LS9 as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point LS9. The average flow, measured at the sampling point LS9 (56.74 MGD) using the U.S. Geological Survey stream gauge (#01469500), is used for these computations. The loads calculated at LS9 will directly affect the downstream point LS11.

There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point LS9 shows pH ranging between 6.0 and 7.2; pH will be addressed as part of this TMDL.

The measured and allowable loading for point LS9 for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The existing load for each parameter from point LS8 was subtracted from the existing load at point LS9 to determine a remaining load that was then added to the allowable load from LS8 to calculate the total load for the segment of stream between LS8 and LS9. This total load will be compared to the calculated allowable load at LS9 to determine if further reductions are needed to meet the calculated TMDL at LS9.

A TMDL for acidity at LS9 has been calculated. All measured sample data for aluminum fell below detection limits. The measured sample data for iron and manganese were above detection limits but fell below applicable water quality criteria limits. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated. The existing and allowable load for aluminum values at LS9 in Table C17 will be denoted as "NA".

Table C18 shows the measured and allowable concentrations and loads at LS9. Table C19 shows the percent reduction required for acidity at sample point LS9.

Table C18		Measured		Allowable	
Flow (gpm)=	39402.89	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	ND	NA		
	Iron	0.41	195.72	0.41	195.72

	Manganese	0.09	41.57	0.09	41.57
ND = non detection	Acidity	4.25	2012.40	1.40	664.09
NA = not applicable	Alkalinity	14.19	6714.64		

Table C19. Allocations LS9	
LS9	Acidity (Lbs/day)
Existing Load @ LS9	2012.40
Difference in measured Loads between upstream loads and existing LS9	-4573.25
Percent loss due calculated at LS9	69%
Additional load tracked from above samples	889.82
Percentage of upstream loads that reach the LS9	31%
Total load tracked between LS8 and LS9	271.91
Allowable Load @ LS9	664.09
Load Reduction @ LS9	0
% Reduction required at LS9	0%

Sample data for acid show that the load tracked from LS8 is lower than the allowable load at LS9; therefore, no reduction is necessary at LS9. Sample data show water quality standards are being met for iron, manganese, and aluminum at LS9; therefore, no reductions are necessary.

Panther Creek TMDL Calculation

A TMDL was completed for the Panther Creek watershed and revised. Panther Creek enters the Little Schuylkill River above sample point LS11. The allowable loads from the most downstream monitoring point in Panther Creek (003) are used in the calculation of the Little Schuylkill TMDL.

Table C20. Panther Creek Contributions				
Sample 003	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ 003	384.0	468.4	444.3	249.2
Allowable Load @ 003	115.0	319.0	178.0	249.2

Waste Load Allocation – Outfalls 001, 003 and 004, BET Associates Discharges to Panther Creek and/or 005 to Little Schuylkill River

BET Associates (SMP 54733020R2 & R3CB, PA0012360) is proposing to discharge from Outfalls 001, 003 and 004 into Panther Creek, a tributary to the Little Schuylkill River. The Waste Load Allocation associated with BET Associates' permit is determined from projected maximum discharge volume and in-stream criteria for aluminum and iron. The manganese WLA was calculated using projected maximum discharge volume and the average allowable monthly concentration as calculated by PennToxSD. The following table shows the waste load allocation for this discharge.

Table C21. BET Waste Load Allocations at Outfall 005		
Parameter	Average Flow (MGD)	Allowable Load (lbs/day)
Outfall 005		
Al	14.4	90.1
Fe	14.4	180.1
Mn**	14.4	168.0

** Manganese in-stream criterion of 1.0 mg/l for protection of water supply use criterion based on potential for objectionable taste and laundry staining

Wabash Creek TMDL Calculation

A TMDL was completed on the Wabash Creek watershed. Wabash Creek enters the Little Schuylkill River above sample point LS11. The allowable loads for Wabash Creek most downstream point (11WB) are used in the calculation of the Little Schuylkill TMDL.

Table C22. Wabash Creek Contributions				
Sample 11WB	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ 11WB	46.3	9.8	18.6	368.2
Allowable Load @ 11WB	6.0	9.8	9.7	11.0

TMDL Calculation – LS11 – Little Schuylkill River 1.2 miles downstream of Rt. 309 discharge

The TMDL for sampling point LS11 on the Little Schuylkill River consists of a load allocation of the entire area above point LS11 as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point LS11. The average flow, calculated using the unit area method at the sampling point LS11 (98.40 MGD), is used for these computations. The allowable loads calculated at LS11 will directly affect the downstream point LS13.

There currently is an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point LS11 shows pH ranging between 6.3 and 6.7; pH will be addressed as part of this TMDL.

The measured and allowable loading for point LS11 for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The existing load for each parameter from points LS9, Panther and Wabash Creek (LS9/Pan/Wab) was subtracted from the existing load at point LS11 to determine a remaining load that was then added to the allowable loads from LS/Pan/Wab/11WB to calculate the total load for the segment of stream between LS/Pan/Wab and LS11. This total load will be compared to the calculated allowable load at LS11 to determine if further reductions are needed to meet the calculated TMDL at LS11.

A TMDL for each parameter at LS11 has been calculated. Table C23 shows the measured and allowable concentrations and loads at LS11. Table C24 shows the percent reduction required for aluminum, iron, manganese and acidity at sample point LS11.

Table C23		Measured		Allowable	
Flow (gpm)=	68316.49	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	0.65	533.43	0.28	229.78
	Iron	2.23	1830.06	0.55	451.36
	Manganese	1.36	1116.09	0.31	254.40
	Acidity	14.96	12277.01	2.48	2035.23
	Alkalinity	17.60	14443.12		

Table C24. Allocations LS11				
LS11	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS11	533.43	1830.06	1116.09	12277.01
Difference in measured loads between upstream loads and existing LS11	103.13	1156.14	611.62	9647.21
Percent loss due calculated at LS11	0%	0%	0%	0%
Additional load tracked from above samples	121.00	524.52	229.27	924.29
Percentage of upstream loads that reach the LS11	100%	100%	100%	100%
Total load tracked between LS9/Wabash/Panther and LS11	224.13	1680.66	840.89	10571.50
Allowable Load @ LS11	229.78	451.36	254.4	2035.23
Load Reduction @ LS11	0	1229.3	586.49	8536.27
% Reduction required at LS11	0%	73%	70%	81%

Sample data show 105.77 lbs/day of aluminum entered the Little Schuylkill River at this segment resulting in an existing load of 533.43 lbs/day. The total aluminum load tracked between LS9/Panther/Wabash and LS11 was shown to be 224.13 lbs/day. This was less than the calculated allowable load of 229.78 lbs/day; therefore, no aluminum reduction is necessary at LS11. Calculations showed an increase of 1156.14 lbs/day iron loading in the segment of stream between LS9/Panther/Wabash and LS11. A total iron load tracked through this segment showed that it was 1229.3 lbs/day more than the calculated allowable LS11 load of 451.36 lbs/day. Therefore, a 73% iron loading reduction is necessary at LS11. The existing manganese load was measured to be 1116.09 lbs/day, with an increase of manganese loads between LS9/Panther/Wabash of 611.62 lbs/day. The total load tracked was 586.49 lbs/day more than the calculated LS11 allowable load of 254.4 lbs/day. A 70% reduction is necessary in manganese loads at LS11. The existing acidic load was measured at 12277.01 lbs/day. The total load tracked between LS9/Panther/Wabash and LS11 was found to be 8536.27 lbs/day greater than the calculated acidic allowable load of 2035.23 lbs/day at LS11. Therefore, an 81% acidic reduction is necessary.

TMDL Calculation – LSNR – downstream of Route 443 bridge in New Ringgold

The TMDL for sampling point LSNR on the Little Schuylkill River consists of a load allocation of the entire area above point LSNR as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point LSNR. The average flow, using the unit area method at the sampling point LSNR (145.28 MGD), is used for these computations. The allowable loads calculated at LSNR will directly affect the downstream point LS13.

There currently is an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point LSNR shows pH ranging between 7.0 and 7.4. pH will be addressed as part of this TMDL.

The measured and allowable loading for point LSNR for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The existing load for each parameter from point LS11 was subtracted from the existing load at point LSNR to determine a remaining load that was added to the allowable load from LS11 to calculate the total load for the segment of stream between LS11 and LSNR. This total load will be compared to the calculated allowable load at LSNR to determine if further reductions are needed to meet the calculated TMDL at LSNR.

Table C25 shows the measured and allowable concentrations and loads at LSNR. Table C26 shows the percent reduction required for aluminum, iron, manganese and acidity at sample point LSNR.

Table C25		Measured		Allowable	
Flow (gpm)=	100888.89	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	ND	NA		
	Iron	0.58	702.75	0.43	521.00
	Manganese	0.75	908.73	0.48	581.58
	Acidity	2.60	3150.25	0.29	351.37
	Alkalinity	21.15	25626.08		

Table C26. Allocations LSNR			
LSNR	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LSNR	702.75	908.73	3150.25
Difference in measured loads between upstream loads and existing LSNR	-1127.31	-207.36	-9126.76
Percent loss due calculated at LSNR	62%	19%	74%
Additional load tracked from above samples	451.36	254.40	2035.23
Percentage of upstream loads that reach the LSNR	38%	81%	26%
Total load tracked between LS11 and LSNR	173.32	207.13	522.23
Allowable Load @ LSNR	521.00	581.58	351.37
Load Reduction @ LSNR	0.00	0.00	170.86
% Reduction required at LSNR	0%	0%	33%

The existing iron load was measured to be 702.75 lbs/day. The total load tracked was less than the calculated LSNR allowable load of 521.00 lbs/day, therefore no iron reduction is necessary. The total manganese load tracked between LS11 and LSNR was found to be less than the calculated manganese allowable load of 581.58 lbs/day, therefore no manganese reduction is necessary. The existing acidic load was measured at 3150.25 lbs/day. The calculated allowable load was 351.37 lbs/day which required a 170.86 lbs/day or 33% reduction from the total acidic load tracked between LS11 and LSNR.

TMDL Calculation – LS13 – mouth of Little Schuylkill River

The TMDL for sampling point LS13 consists of a load allocation of the entire area above point LS13 as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point LS13. The average flow, calculated using a ratio method at sampling point LS13 (192.16 MGD), is used for these computations.

There currently is an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point LS13 shows pH ranging between 6.3 and 7.6; pH will be addressed as part of this TMDL.

The measured and allowable loading for point LS13 for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The existing load for each parameter from point LSNR was subtracted from the actual load at point LS13 to determine a remaining load that was added to the allowable load from LSNR to calculate the total load for the segment of stream between LSNR and LS13. This total load will be compared to the calculated allowable load at LS13 to determine if further reductions are needed to meet the calculated TMDL at LS13.

A TMDL for aluminum, iron, manganese and acidity at LS13 have been calculated. Table C27 shows the measured and allowable concentrations and loads at LS13. Table C28 shows the percent reduction required for aluminum, iron and acidity at sample point LS13.

Table C27		Measured		Allowable	
Flow (gpm)=	133444.44	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	0.56	897.46	0.33	528.86
	Iron	0.50	801.31	0.34	544.89
	Manganese	0.33	528.86	0.31	496.81
	Acidity	7.48	11987.56	1.72	2756.50
	Alkalinity	16.85	28067.39		

Table C28. Allocations LS13				
LS13	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ LS13	897.46	801.31	528.86	11987.56
Difference in measured Loads between upstream loads and existing LS13	NA	98.56	-379.87	8837.31
Percent loss due calculated at LS13	0%	0%	42%	0%
Additional load tracked from above samples	NA	521.00	581.58	351.37
Percentage of upstream loads that reach LS13	100%	100%	58%	100%
Total load tracked between LSNR and LS13	897.46	619.56	338.47	9188.68
Allowable Load @ LS13	528.86	544.89	496.81	2756.50
Load Reduction @ LS13	368.60	74.67	0.00	6432.18
% Reduction required at LS13	41%	12%	0%	70%

The existing aluminum load is 897.46 lbs/day. The total aluminum load tracked at this segment of river was 368.60 lbs/day greater than the calculated aluminum allowable load of 528.86 lbs/day; therefore a 41% aluminum reduction is necessary. The existing iron load is 801.31 lbs/day. The total iron load tracked at this segment of river was 74.67 lbs/day greater than the calculated iron allowable load of 544.89 lbs/day; therefore a 12% iron reduction is necessary.

The existing manganese load is 528.86 lbs/day. The total manganese load tracked at this segment of river was less than the calculated manganese allowable load of 496.81 lbs/day; therefore no manganese reduction is necessary. The existing acid load is 11987.56 lbs/day. The total acid load tracked at this segment of river was 6432.18 lbs/day greater than the calculated acid allowable load of 2756.50 lbs/day; therefore a 70% acidic reduction is necessary.

Margin of Safety

PADEP used an implicit MOS in these TMDLs derived from the Monte Carlo statistical analysis. The Water Quality standard states that water quality criteria must be met at least 99% of the time. All of the @Risk analyses results surpass the minimum 99% level of protection. Another margin of safety used for this TMDL analysis results from:

- Effluent variability plays a major role in determining the average value that will meet water-quality criteria over the long-term. The value that provides this variability in our analysis is the standard deviation of the dataset. The simulation results are based on this variability and the existing stream conditions (an uncontrolled system). The general assumption can be made that a controlled system (one that is controlling and stabilizing the pollution load) would be less variable than an uncontrolled system. This implicitly builds in a margin of safety.

- A MOS is also the fact that the calculations were performed with a daily Iron average instead of the 30-day average.

Seasonal Variation

Seasonal variation is implicitly accounted for in these TMDLs because the data used represents all seasons.

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis.

Attachment D
Little Schuylkill River Sediment Calculations

Little Schuylkill River Sediment TMDL Calculations

The AVGWLF model produced information on watershed size, land use, and sediment loading. The sediment loads represent an annual average over the 23 years simulated by the model (1975 to 1998). This information was then used to calculate existing unit area loading rates for the Little Schuylkill River and Meshoppen Creek Watersheds.

Table A. Existing Loading Values for Little Schuylkill River (impaired)			
Source	Area (ac)	Sediment (lbs.)	Unit Area Load (lb/ac/yr)
Hay/Past	5725.4	1186520	207.24
Cropland	9390	35847600	3817.64
Conif_for	5162	57380	11.12
Mixed_for	3123.4	35640	11.41
decid_for	56512.9	2055560	36.37
unpaved_rd	66.7	820220	12297.15
coal_mine/quarry	2742.8	74456180	27146.05
transition	96.4	1360360	14111.62
lo_int_dev	766	71220	92.98
hi_int_dev	1146.6	161780	141.10
stream bank	****	10748460	
total	84732.2	126,800,920.00	1496.49

Table B. Existing Loading Values for Meshoppen Creek Watershed (reference)			
Source	Area (ac)	Sediment (lbs.)	Unit Area Load (lb/ac/yr)
Hay/Past	5646.3	1101080	195.01
Cropland	20455.4	69723320	3408.55
Conif_for	4265	35520	8.33
Mixed_for	5918	104180	17.60
decid_for	35118.6	760440	21.65
unpaved_rd	355.8	2643700	7430.30
transition	7.4	125360	16940.54
lo_int_dev	106.3	2760	25.96
hi_int_dev	108.7	4200	38.64
stream bank	****	7227540	
total	71981.5	81728100	1135.40

The TMDL target sediment load for Little Schuylkill River is the product of the unit area sediment-loading rate in the reference watershed (Meshoppen Creek) and the total area of the impaired watershed (Little Schuylkill River). These numbers and the resulting TMDL target load are shown in Table C on the following page.

Table C. TMDL Total Load Computation				
Pollutant	Unit Area Loading Rate in Meshoppen Creek Watershed (lbs/acre/yr)	Total Watershed Area in Little Schuylkill River (acres)	TMDL Total Load (lbs/year)	TMDL Total Load (lbs/day)
Sediment	1135.4	84732.2	96,205,298.79	263576.16

Targeted TMDL values were used as the basis for load allocations and reductions in the Little Schuylkill River Watershed, using the following equation

1. TMDL = LA+WLA+MOS
2. LA = ALA-LNR

Where:

TMDL = Total Maximum Daily Load
LA = Load Allocation
ALA = Adjusted Load Allocation
LNR = Loads Not Reduced
WLA = Waste Load Allocation
MOS = Margin of Safety

Waste Load Allocation

There is an NPDES permit at BET Associates (SMP54733020, NPDES PA0012360) Outfall 005 (Route 309 discharge) with suspended solids effluent limits to discharge into the Little Schuylkill River. The WLA for BET was calculated as 4203 lbs/day or 1,534,226 lbs/year. There is also a surface mining permit issued to Maziaka Coal Company with suspended solids effluent limits to discharge into the Little Schuylkill River. The WLA for Maziaka was calculated as 13 lbs/day or 4,745 lbs/year. Additionally, a bulk allocation equal to 2% of the allowable load was included to account for general permits or other contributors that are present now or in the future.

TABLE D. SUSPENDED SOLIDS WASTE LOAD ALLOCATIONS IN LITTLE SCHUYLKILL RIVER WATERHSED			
Parameter	Monthly Avg. Allowable Conc. (mg/L)	Average Flow (MGD)	Allowable Load (lbs/day)
Maziaka Coal Company	35.0	0.0445	13
BET	35.0	14.4	4203
Bulk Allocation	N/A	N/A	5272

Margin of Safety

The margin of safety (MOS) is that portion of the pollution loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. The Margin of Safety (MOS) for this analysis is explicit. Ten percent of the TMDL was reserved as the MOS.

MOS = 0.1 * 96,205,299

MOS = 9,620,529.9 lbs/yr

Load Allocation

The Load Allocation (LA), the portion of the load consisting of all nonpoint sources in the watershed, was computed by subtracting the Margin of Safety from the TMDL total load.

LA = TMDL – MOS - WLA

LA = 96,205,299 – 9,620,529.9 – 3,463,121

LA = 83,121,648 lbs/year

Adjusted Load Allocation

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those non-point sources receiving reductions. It is computed by subtracting those non-point source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Reductions in the Little Schuylkill River Watershed were applied to COAL_MINES/QUARRY and CROPLAND sources for sediment. Those land uses/sources for which existing loads were not reduced (HAY/PAST, CONIF_FOR, MIXED_FOR, DECID_FOR, UNPAVED_RD, TRANSITION, LO_INT_DEV, HI_INT_DEV and Stream bank) kept their current loading values, Table D. The ALA for sediment is 66,629,254 lbs/yr.

Table E. Load Allocation, Loads Not Reduced and Adjusted Load Allocations for the Little Schuylkill River Sediment TMDL

	Sediment (lbs./yr)	Sediment (lbs/day)
Load Allocation	83121648	227731
Loads Not Reduced	16497140	45198
Hay/Past	1186520	3251
Conif_for	57380	157
Mixed_for	35640	98
decid_for	2055560	5632
unpaved_rd	820220	2247
transition	1360360	3727
lo_int_dev	71220	195
hi_int_dev	161780	443
stream bank	10748460	29448
Adjusted load allocation	66624508	182533

TMDL

The sediment TMDL for the Little Schuylkill River Watershed consists of a Load Allocation and a Margin of Safety (MOS). The individual components of the TMDL are summarized in Table E.

Table F. TMDL, WLA, MOS, LA, LNR and ALA for Little Schuylkill River Sediment TMDL		
Component	Sediment (lbs/year)	Sediment (lbs/day)
TMDL (Total Maximum Daily Load)	96,205,299	263,576
WLA (Waste Load Allocation)	3,463,121	9,488
MOS (Margin of Safety)	9,620,530	26,357
LA (Load Allocation)	83,121,648	227,731
LNR (Loads Not Reduced)	16,497,140	45,198
ALA (Adjusted Load Allocation)	66,624,508	182,533

Calculation of Sediment Load Reductions

Adjusted Load Allocations established in the previous section represents the sediment load that is available for allocation between contributing sources in the Little Schuylkill River Watershed. Data needed for load reduction analysis, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method (Attachment F) was used to distribute the ALA between the appropriate contributing land uses.

Table F contains the results of the sediment EMPR analysis for the appropriate contributing land uses in the Little Schuylkill River Watershed. The load allocation for each land use is shown, along with the percent reduction of current loads necessary.

Table G. Sediment Source Load Allocation Summary for Little Schuylkill River Watershed			
Source	Current Loading (lbs/yr.)	Allowable Loading (lbs/yr.)	Percent Reduction (%)
COAL_MINES/QUARRY	74,456,180	43,317,398	42%
CROPLAND	35,847,600	23,307,110	35%
NPS Loads Not Reduced	16,497,140	16,497,140	-
Total	126,800,920	83,121,648	34%

Consideration of Critical Conditions

The AVGWLF model is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment loads based on the daily water balance accumulated to monthly values. Therefore, all flow conditions are taken into account for loading calculations. Because there is generally a significant lag time between the introduction of sediment to a waterbody and the resulting impact on beneficial uses, establishing these TMDLs using average annual conditions is protective of the waterbody.

Consideration of Seasonal Variations

The continuous simulation model used for this analysis considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions by the model accounts for seasonal variability.

Attachment E

AVGWLF Model Overview & GIS-Based Derivation of Input Data

TMDLs for the Little Schuylkill River Watershed were developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff, sediment, and nutrient (N and P) loadings from watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values.

GWLF is a combined distributed/lumped parameter watershed model. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios. Each area is assumed to be homogenous in regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but aggregates the loads from each area into a watershed total. In other words, there is no spatial routing. For sub-surface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for sub-surface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated sub-surface zone, where infiltration is computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

GWLF models surface runoff using the Soil Conservation Service Curve Number (SCS-CN) approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation (USLE) algorithm (with monthly rainfall-runoff coefficients) and a monthly composite of KLSCP values for each source area (e.g., land cover/soil type combination). The KLSCP factors are variables used in the calculations to depict changes in soil loss erosion (K), the length slope factor (LS) the vegetation cover factor (C) and conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacities based on average daily runoff are applied to the calculated erosion to determine sediment yield for each source area. Surface nutrient losses are determined by applying dissolved N and P coefficients to surface runoff and a sediment coefficient to the yield portion for each agricultural source area. Point source discharges can also contribute to dissolved losses to the stream and are specified in terms of kilograms per month. Manured areas, as well as septic systems, can also be considered. Urban nutrient inputs are all assumed to be solid-phase, and the model uses an exponential accumulation and washoff function for these loadings. Sub-surface losses are calculated using dissolved N and P coefficients for shallow groundwater contributions to stream nutrient loads, and the sub-surface sub-model only considers a single, lumped-parameter contributing area. Evapotranspiration is determined using daily weather data and a cover factor dependent upon land use/cover type. Finally, a water balance is performed daily using supplied or computed precipitation, snowmelt, initial unsaturated zone storage, maximum available zone storage, and evapotranspiration values. All of the equations used by the model can be viewed in GWLF Users Manuel, available from the Department's Bureau of Water Supply and Wastewater Management, Division of Water Quality Assessment and Standards.

For execution, the model requires three separate input files containing transport-, nutrient-, and weather-related data. The transport (TRANSPRT.DAT) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.) as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The nutrient (NUTRIENT.DAT) file specifies the various loading parameters for the different source areas identified (e.g., number of septic systems, urban source area accumulation rates, manure concentrations, etc.). The weather (WEATHER.DAT) file contains daily average temperature and total precipitation values for each year simulated.

The primary sources of data for this analysis were geographic information system (GIS) formatted databases. A specially designed interface was prepared by the Environmental Resources Research Institute of the Pennsylvania State University in ArcView (GIS software) to generate the data needed to run the GWLF model, which was developed by Cornell University. The new version of this model has been named AVGWLF (ArcView Version of the Generalized Watershed Loading Function).

In using this interface, the user is prompted to identify required GIS files and to provide other information related to "non-spatial" model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land and the names of nearby weather stations). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT, NUTRIENT.DAT and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, AVGWLF has been linked with statewide GIS data layers such as land use/cover, soils, topography, and physiography; and includes location-specific default information such as background N and P concentrations and cropping practices. Complete GWLF-formatted weather files are also included for eighty weather stations around the state. The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.

GIS Data Sets	
DATASET	DESCRIPTION
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute *usew_sept* includes data on conventional systems, and *sew_other* provides data on short-circuiting and other systems.
County	The County boundaries coverage lists data on conservation practices, which provides C and P values in the Universal Soil Loss Equation (USLE).
Gwnback	A grid of background concentrations of N in groundwater derived from water well sampling.
Landuse5	Grid of the MRLC that has been reclassified into five categories. This is used primarily as a background.
Majored	Coverage of major roads. Used for reconnaissance of a watershed.
MCD	Minor civil divisions (boroughs, townships and cities).
Npdespts	A coverage of permitted point discharges. Provides background information and cross check for the point source coverage.
Padem	100-meter digital elevation model. This used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different landcover categories. This dataset provides landcover loading rate for the different categories in the model.
Pasingle	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
Physprov	A shapefile of physiographic provinces. Attributes *rain_cool* and *rain_warm* are used to set recession coefficient
Pointsrc	Major point source discharges with permitted N and P loads.
Refwater	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
Soilphos	A grid of soil phosphorous loads, which has been generated from soil sample data. Used to help set phosphorus and sediment values.
Smallsheds	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
Statsgo	A shapefile of generalized soil boundaries. The attribute *mu_k* sets the k factor in the USLE. The attribute *mu_awc* is the unsaturated available capacity., and the *muhsg_dom* is used with landuse cover to derive curve numbers.
Strm305	A coverage of stream water quality as reported in the Pennsylvania's 305(b) report. Current status of assessed streams.
Surfgeol	A shapefile of the surface geology used to compare watersheds of similar qualities.
T9sheds	Data derived from a DEP study conducted at PSU with N and P loads.
Zipcode	A coverage of animal densities. Attribute *aeu_acre* helps estimate N & P concentrations in runoff in agricultural lands and over manured areas.
Weather Files	Historical weather files for stations around Pennsylvania to simulate flow.

Attachment F

Equal Marginal Percent Reduction (EMPR)

Equal Marginal Percent Reduction (EMPR) (An Allocation Strategy)

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute Adjusted Load Allocations (ALAs) between the appropriate contributing nonpoint sources. The load allocation and EMPR procedures were performed using a MS Excel spreadsheet. The 5 major steps identified in the spreadsheet are summarized below:

Step 1: Calculation of the TMDL based on impaired watershed size and unit area loading rate of reference watershed.

Step 2: Calculation of Adjusted Load Allocation based on TMDL, Margin of Safety, and existing loads not reduced.

Step 3: Actual EMPR Process:

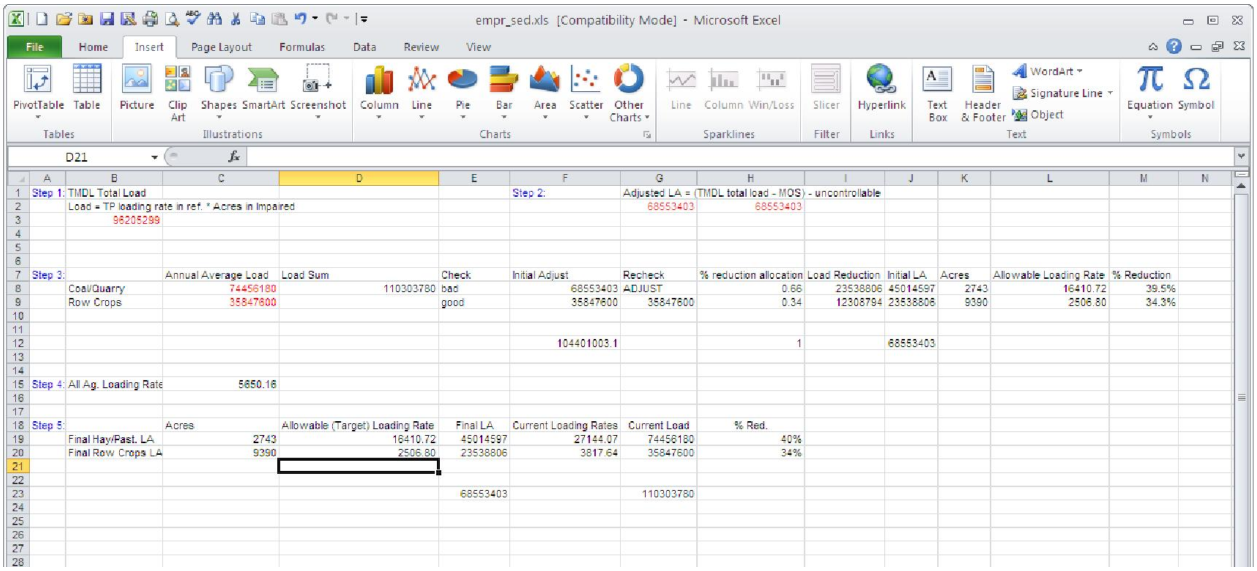
a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving waterbody. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of EMPR.

b. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

Step 4: Calculation of total loading rate of all sources receiving reductions.

Step 5: Summary of existing loads, final load allocations, and % reduction for each pollutant source.

Equal Marginal Percent Reduction Calculations in Lbs. for Little Schuylkill River



empr_sed.xls [Compatibility Mode] - Microsoft Excel

D21

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable							
2		Load = TP loading rate in ref. * Acres in Impaired					68553403	68553403						
3		96205299												
4														
5														
6														
7	Step 3:		Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction	
8		Coal/Quarry	74456180	110303780	bad	68553403	ADJUST	0.66	23538806	45014597	2743	16410.72	39.5%	
9		Row Crops	35847600		good	35847600	35847600	0.34	12308794	23538806	9390	2506.80	34.3%	
10														
11														
12						104401003.1		1		68553403				
13														
14														
15	Step 4:	All Ag. Loading Rate	5650.16											
16														
17														
18	Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.						
19		Final Hay/Past. LA	2743	16410.72	45014597	27144.07	74456180	40%						
20		Final Row Crops LA	9390	2506.80	23538806	3817.64	35847600	34%						
21														
22														
23					68553403		110303780							
24														
25														
26														
27														
28														

Equal Marginal Percent Reduction Calculations in tons for Little Schuylkill River

Attachment G
AVGWLF OUTPUT

AVGWLF Transport File and Model Output for Little Schuylkill River

Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	2317	75	0.22481	2.75367	0.03	0.45
CROPLAND	3800	82	0.22066	3.69139	0.42	0.45
CONIF_FOR	2089	73	0.21046	2.36646	0.002	0.45
MIXED_FOR	1264	73	0.21618	2.36443	0.002	0.45
DECID_FOR	22870	73	0.20758	6.79451	0.002	0.52
UNPAVED_RD	27	87	0.20840	2.97363	0.8	1
QUARRY	407	91	0.18149	12.3975	0.8	0.8
COAL_MINES	703	89	0.17561	7.96047	0.8	0.8

Urban LU	Area (ha)	CN	K	LS	C	P
LO_INT_DEV	310	83	0.20141	1.16338	0.08	0.2
HI_INT_DEV	464	93	0.18788	1.89287	0.08	0.2

Month	Ket	Day Hrs	Season	Eros Coef
APR	0.6866	13	1	0.300
MAY	0.9312	14	1	0.300
JUN	1.0731	15	1	0.300
JUL	1.1554	15	1	0.300
AUG	1.2032	14	1	0.300
SEP	1.2309	12	1	0.300
OCT	1.2469	11	1	0.120
NOV	0.8407	10	0	0.120
DEC	0.6051	9	0	0.120
JAN	0.2350	9	0	0.120
FEB	0.2538	10	0	0.120
MAR	0.2648	12	0	0.120

Antecedent Moisture Condition

Day -1	Day -2	Day -3	Day -4	Day -5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.078
Recess Coef (l/day)	0.10021	Sediment A Factor	4.784E-05
Seepage Coef (l/day)	0	Unsat Avail Wat (cm)	12.8838

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Average Loads by Source

GWLF Total Loads for imp1

Period of analysis: 23 years, from Apr 1975 to Mar 1998

Source	(Acres) Area	(in) Runoff	(Tons) Erosion	(Tons) Sediment	Total Loads (Pounds) Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	5725.4	3.78	7605.92	593.26	13048.39	16607.96	1446.91	1946.44
CROPLAND	9390.0	6.11	229792.29	17923.80	34529.45	142072.24	3838.91	18930.75
CONIF_FOR	5162.0	3.31	367.81	28.69	736.28	908.41	23.25	47.41
MIXED_FOR	3123.4	3.31	228.40	17.82	445.50	552.40	14.07	29.07
DECID_FOR	56512.9	3.31	13176.70	1027.78	8060.68	14227.38	254.55	1119.94
UNPAVED_RD	66.7	8.90	5257.82	410.11	390.43	2851.09	26.93	372.24
QUARRY	1005.7	12.61	230220.99	17957.24	34.50	107777.92	5.46	15125.46
COAL_MINES	1737.1	10.52	247062.17	19270.85	49.72	115674.81	7.87	16233.93
TRANSITION	96.4	8.90	8720.30	680.18	563.95	4645.05	38.89	611.61
LO_INT_DEV	766.0	6.56	456.53	35.61	0.00	106.33	0.00	14.18
HI_INT_DEV	1146.6	15.40	1037.10	80.89	0.00	5149.76	0.00	571.06
Stream Bank				5374.23		537.42		236.47
Groundwater					227697.13	227697.13	5909.22	5909.22
Point Sources					186808.48	186808.48	4214.70	4214.70
Septic Syst.					28996.44	28996.44	268.19	268.19
Totals	84732.3	4.10	743926.0	63400.4	501360.93	854612.80	16048.96	65630.65

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AVGWLF Transport File and Model Output for Meshoppen Creek

Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	2285	75	0.24807	3.19756	0.03	0.45
CROPLAND	8278	82	0.24767	3.99862	0.42	0.45
CONIF_FOR	1726	73	0.24669	2.06007	0.002	0.45
MIXED_FOR	2395	73	0.24657	3.76943	0.002	0.52
DECID_FOR	14212	73	0.24730	4.62313	0.002	0.52
UNPAVED_RD	144	87	0.24741	2.06125	0.8	1
TRANSITION	3	87	0.25	5.80422	0.8	0.8

Urban LU	Area (ha)	CN	K	LS	C	P
LO_INT_DEV	43	83	0.27441	0.32452	0.08	0.2
HI_INT_DEV	44	93	0.25068	0.52908	0.08	0.2

Month	Ket	Day Hrs	Season	Eros Coef
APR	0.7373	13	1	0.300
MAY	0.9554	14	1	0.300
JUN	1.0819	15	1	0.300
JUL	1.1552	15	1	0.300
AUG	1.1978	14	1	0.300
SEP	1.2225	12	1	0.300
OCT	1.2368	11	1	0.120
NOV	0.8777	10	0	0.120
DEC	0.6694	9	0	0.120
JAN	0.3207	9	0	0.120
FEB	0.3464	10	0	0.120
MAR	0.3612	12	0	0.120

Antecedent Moisture Condition

Day -1	Day -2	Day -3	Day -4	Day -5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.083
Recess Coef (l/day)	0.10012	Sediment A Factor	4.320E-05
Seepage Coef (l/day)	0	Unsat Avail Wat (cm)	11.7862

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Average Loads by Source

GWLF Total Loads for ref2

Period of analysis: 23 years, from Apr 1975 to Mar 1998

Source	(Acres) Area	(in) Runoff	(Tons) Erosion	(Tons) Sediment	Total Loads (Pounds) Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	5646.3	2.42	6633.03	550.54	8230.76	11534.01	909.56	1786.02
CROPLAND	20455.4	4.15	420020.00	34861.66	51239.57	260409.53	5648.21	61147.97
CONIF_FOR	4265.0	2.08	214.00	17.76	381.32	487.90	12.04	40.32
MIXED_FOR	5918.2	2.08	627.55	52.09	529.12	841.64	16.71	99.63
DECID_FOR	35118.6	2.08	4580.94	380.22	3139.84	5421.15	99.15	704.46
UNPAVED_RD	355.8	6.29	15925.87	1321.85	1470.58	9401.66	101.42	2205.80
TRANSITION	7.4	6.29	755.22	62.68	30.64	406.74	2.11	101.91
LO_INT_DEV	106.3	4.50	16.61	1.38	0.00	0.42	0.00	0.06
HI_INT_DEV	108.7	11.34	25.31	2.10	0.00	11.01	0.00	1.22
Stream Bank				3613.77		361.38		159.01
Groundwater					75776.74	75776.74	3178.63	3178.63
Point Sources					0.00	0.00	0.00	0.00
Septic Syst.					24141.43	24141.43	127.71	127.71
Totals	71981.7	2.70	448798.5	40864.1	164939.99	388793.60	10095.54	69552.73

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Attachment H

Excerpts Justifying Changes Between the 1996, 1998, 2002, and 2004 Section 303(d) Lists

The following are excerpts from the Pennsylvania DEP 303(d) narratives that justify changes in listings between the 1996, 1998, 2002, and 2004 lists. The 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

In the 1996 303(d) narrative, strategies were outlined for changes to the listing process. Suggestions included, but were not limited to, a migration to a Global Information System (GIS), improved monitoring and assessment, and greater public input.

The migration to a GIS was implemented prior to the development of the 1998 303(d) list. As a result of additional sampling and the migration to the GIS some of the information appearing on the 1996 list differed from the 1998 list. Most common changes included:

1. mileage differences due to recalculation of segment length by the GIS;
2. slight changes in source(s)/cause(s) due to new EPA codes;
3. changes to source(s)/cause(s), and/or miles due to revised assessments;
4. corrections of misnamed streams or streams placed in inappropriate SWP subbasins; and
5. unnamed tributaries no longer identified as such and placed under the named watershed listing.

Prior to 1998, segment lengths were computed using a map wheel and calculator. The segment lengths listed on the 1998 303(d) list were calculated automatically by the GIS (ArcInfo) using a constant projection and map units (meters) for each watershed. Segment lengths originally calculated by using a map wheel and those calculated by the GIS did not always match closely. This was the case even when physical identifiers (e.g., tributary confluence and road crossings) matching the original segment descriptions were used to define segments on digital quad maps. This occurred to some extent with all segments, but was most noticeable in segments with the greatest potential for human errors using a map wheel for calculating the original segment lengths (e.g., long stream segments or entire basins).

Attachment I

Water Quality and Flow Data Used In TMDL Calculations

DATE_COLECTED	Project MP	pH (pH units)	AL (UG/L)	ALK (MG/L)	FE (UG/L)	HOT A (MG/L)	MN (UG/L)	TSS (MG/L)
6/25/2002	LS1	3.7	4990.00	0.0	7770.00	73.60	1410.00	4
7/25/2002	LS1	3.9	7000.00	0.0	13900.00	84.40	1800.00	<3
8/19/2002	LS1	4.0	7190.00	2.0	13600.00	86.80	1780.00	<3
11/26/2002	LS1	3.7	4780.00	0.0	5100.00	58.00	1170.00	<3
1/6/2003	LS1	3.8	3710.00	0.0	2740.00	52.20	950.00	8
3/24/2003	LS1	4.0	4130.00	0.0	2240.00	52.40	965.00	<3
4/30/2003	LS1	3.7	5490.00	0.0	4370.00	75.20	1410.00	<3
6/2/2003	LS1	4.2	2250.00	2.6	1580.00	38.00	578.00	<3
5/26/2004	LS1	3.7	5240.00	0.0	4580.00	67.40	1420.00	<3
AVG		**3.9**	**4975.6**	**0.5**	**6208.9**	**65.3**	**1275.9**	
4/18/1972	LS2*	3.8			10000.00			
11/1/1991	LS2*	4.3			19000.00		1900.00	
1/3/2000	LS2*	3.9		0.0	19700.00	110.00	1800.00	0
2/2/2000	LS2*	4.0		0.0	18200.00	110.00	1600.00	0
3/11/2000	LS2*	3.8		0.0	16700.00	110.00	1800.00	1
4/15/2000	LS2*	3.9		0.0	14000.00	100.00	1500.00	0
5/1/2000	LS2*	3.7		0.0	13600.00	95.00	1500.00	0
6/2/2000	LS2*	4.0		0.0	11600.00	95.00	1900.00	1
7/3/2000	LS2*	3.8		0.0	10800.00	90.00	1400.00	0
8/2/2000	LS2*	3.7		0.0	11200.00	90.00	1600.00	0
9/5/2000	LS2*	3.8		0.0	15400.00	115.00	1500.00	0
11/8/2000	LS2*	4.2	10600.00	7.0	23000.00	102.00	1950.00	<2
1/3/2001	LS2*	4.2		0.0	22300.00	140.00	2000.00	0
2/1/2001	LS2*	4.0		0.0	20100.00	137.00	1800.00	1
3/1/2001	LS2*	4.1		0.0	20400.00	118.00	1800.00	0
4/4/2001	LS2*	4.0		0.0	15600.00	105.00	1600.00	0
5/1/2001	LS2*	3.9		0.0	16000.00	110.00	1600.00	0
6/24/2001	LS2*	3.8		0.0	16200.00	125.00	1500.00	1
10/1/2001	LS2*	4.4		0.0	20700.00	150.00	1600.00	1
11/2/2001	LS2*	4.1		0.0	21900.00	155.00	1600.00	0
12/3/2001	LS2*	4.2		0.0	21000.00	150.00	1400.00	1
1/2/2002	LS2*	4.2		0.0	25000.00	140.00	1700.00	0
2/5/2002	LS2*	4.2		0.0	21200.00	150.00	1400.00	0
3/4/2002	LS2*	4.3		0.0	21600.00	140.00	1300.00	0
4/1/2002	LS2*	4.1		0.0	19900.00	130.00	2000.00	2
5/3/2002	LS2*	4.1		0.0	17400.00	150.00	860.00	0
6/3/2002	LS2*	3.9		0.0	17000.00	130.00	920.00	1
6/25/2002	LS2*	4.2	3970.00	5.2	15400.00	82.20	1360.00	<3
7/25/2002	LS2*	4.1	6690.00	3.0	18400.00	89.00	1640.00	12
8/19/2002	LS2*	3.9	7560.00	1.4	16900.00	86.40	1640.00	<3
11/26/2002	LS2*	4.2	5900.00	4.0	17800.00	101.60	1720.00	<3
1/6/2003	LS2*	4.0	4470.00	1.4	14400.00	84.80	1390.00	10
4/30/2003	LS2*	4.2	<500.00	3.0	12000.00	68.60	1370.00	<3
6/2/2003	LS2*	3.9	4970.00	0.8	9650.00	79.00	1320.00	<3
5/26/2004	LS2*	4.2	3740.00	5.8	13000.00	86.40	1370.00	<3
AVG		**4.0**	**5987.5**	**1.0**	**17058.6**	**112.9**	**1568.8**	
6/25/2002	LS3	4.7	4390.00	8.4	10400.00	64.60	1330.00	44

7/25/2002	LS3	6.0	6100.00	17.6	13600.00	41.80	1620.00	42
8/19/2002	LS3	4.9	6620.00	9.6	14800.00	68.80	1530.00	16
11/26/2002	LS3	4.0	4930.00	2.0	8570.00	81.20	1310.00	<3
1/6/2003	LS3	4.0	4010.00	1.4	7170.00	66.20	1100.00	
3/24/2003	LS3	4.1	4100.00	0.2	4170.00	56.60	1030.00	<3
4/30/2003	LS3	3.9	4860.00	0.2	8680.00	64.00	1340.00	<3
6/2/2003	LS3	4.0	3550.00	1.8	4380.00	52.80	908.00	4
5/26/2004	LS3	4.3	5500.00	6.6	19800.00	87.20	1500.00	52
AVG		**4.4**	**4895.6**	**5.3**	**10174.4**	**64.8**	**1296.4**	
6/25/2002	LS4	5.5	<500.00	7.6	<300.00	14.20	58.00	<3
7/25/2002	LS4	5.8	<500.00	7.4	<300.00	8.60	50.00	12
8/19/2002	LS4	5.5	<500.00	7.6	<300.00	14.00	50.00	<3
11/26/2002	LS4	5.0	<500.00	5.8	<300.00	28.60	79.00	<3
1/6/2003	LS4	5.0	<500.00	6.0	<300.00	19.00	74.00	16
3/24/2003	LS4	4.8	<500.00	6.6	<300.00	23.40	78.00	<3
4/30/2003	LS4	5.1	<500.00	6.6	<300.00	18.20	81.00	<3
6/2/2003	LS4	4.7	<500.00	5.2	<300.00	28.80	80.00	8
5/26/2004	LS4	5.1	<500.00	7.4	<300.00	33.00	88.00	<3
AVG		**5.2**	**<0.5**	**6.7**	**<0.3**	**20.9**	**70.9**	
6/25/2002	LS5	4.5	2170.00	6.8	3930.00	46.60	719.00	<3
7/25/2002	LS5	4.6	3530.00	6.0	6590.00	49.40	999.00	4
8/19/2002	LS5	4.8	4230.00	8.2	8220.00	68.20	1130.00	6
11/26/2002	LS5	4.5	1710.00	5.0	2260.00	44.80	456.00	<3
1/6/2003	LS5	4.5	1550.00	5.2	2090.00	44.20	441.00	12
3/24/2003	LS5	4.5	1510.00	5.2	1630.00	28.00	388.00	4
4/30/2003	LS5	4.3	2100.00	4.6	2420.00	49.40	602.00	<3
6/2/2003	LS5	4.6	927.00	5.0	917.00	43.40	230.00	6
5/26/2004	LS5							
AVG		**4.5**	**2215.9**	**5.8**	**3507.1**	**46.8**	**620.6**	**6.4**
6/25/2002	LS6	4.4	1920.00	6.2	2700.00	40.40	660.00	<3
7/25/2002	LS6	4.4	3510.00	5.0	4880.00	41.20	1000.00	4
8/19/2002	LS6	4.7	3330.00	8.0	4960.00	55.40	982.00	<3
11/26/2002	LS6	4.5	1670.00	5.2	1960.00	39.80	455.00	<3
1/6/2003	LS6	4.6	1420.00	5.4	1760.00	35.00	415.00	6
3/24/2003	LS6	4.6	1520.00	5.8	1570.00	32.40	380.00	4
4/30/2003	LS6	4.4	1690.00	5.2	1740.00	60.40	522.00	<3
6/3/2003	LS6	4.8	1040.00	6.0	1000.00	56.60	266.00	<3
5/26/2004	LS6	4.6	1300.00	6.6	2280.00	50.00	429.00	4
AVG		**4.6**	**1933.33**	**5.93**	**2538.89**	**45.69**	**567.67**	
6/26/2002	LS7	5.7	887.00	7.8	651.00	47.40	354.00	<3
7/25/2002	LS7	5.2	1070.00	6.6	304.00	39.40	522.00	10
8/19/2002	LS7	5.0	931.00	7.8	<300.00	31.80	556.00	
11/25/2002	LS7	5.7	647.00	9.0	643.00	56.20	229.00	8
1/6/2003	LS7	5.9	<500.00	7.2	514.00	45.00	164.00	8
3/27/2003	LS7	6.0	<500.00	9.2	553.00	52.60	155.00	6
4/30/2003	LS7	5.6	<500.00	7.8	478.00	48.00	198.00	<3
6/3/2003	LS7	6.1	<500.00	8.4	884.00	38.80	144.00	<3
5/27/2004	LS7	5.6	<500.00	9.2	622.00	62.60	200.00	<3

AVG		**5.6**		**8.11**	**581.13**	**46.87**	**280.22**	
6/26/2002	LS8	6.9	<500.00	12.4	329.00	0.00	179.00	<3
7/26/2002	LS8	7.1	<500.00	13.4	<300.00	0.00	240.00	<3
8/19/2002	LS8	6.6	<500.00	13.6	<300.00	0.00	304.00	<3
11/25/2002	LS8	6.9	<500.00	13.8	<300.00	0.00	92.00	6
3/27/2003	LS8	6.5	<500.00	11.2	315.00	37.40	82.00	<3
4/30/2003	LS8	6.4	<500.00	10.6	310.00	39.20	113.00	<3
6/3/2003	LS8	6.7	<500.00	11.0	430.00	0.00	73.00	4
5/27/2004	LS8	5.8	<500.00	12.4	346.00	35.80	99.00	<3
AVG		**6.6**	**<0.5**	**12.3**	**346.0**	**14.1**	**147.8**	
6/26/2002	LS9	7.1	<500.00	13.0	<300.00	0.00	94.00	<3
7/26/2002	LS9	7.2	<500.00	14.4	<300.00	0.00	73.00	<3
8/20/2002	LS9	6.6	<500.00	14.6	<300.00	0.00	50.00	6
11/25/2002	LS9	7.0	<500.00	13.8	<300.00	0.00	91.00	
1/7/2003	LS9	6.8	<500.00	10.4	366.00	0.00	95.00	4
3/27/2003	LS9	6.5	<500.00	11.2	<300.00	37.60	84.00	4
4/30/2003	LS9	6.5	<500.00	10.6	<300.00	0.00	105.00	<3
6/3/2003	LS9	6.7	<500.00	11.0	447.00	0.00	83.00	6
5/27/2004	LS9	6.0	<500.00	12.8	476.00	31.60	97.00	<3
5/31/2006	LS9	6.8	<500	12.4	380.00	11.60	89.00	<3
7/24/2006	LS9	7.1	<500	13.6	<300	0.00	90.00	4
8/28/2006	LS9	7.1	<500	15.6	399.00	0.00	124.00	<3
9/7/2006	LS9	7.1	<500	16.0	<300	0.00	74.00	<3
9/11/2006	LS9	6.7	<500	16.4	<300	0.00	63.00	<3
9/18/2006	LS9	6.7	<500	17.4	<300	0.00	64.00	<3
9/25/2006	LS9	6.7	<500	18.0	<300	0.00	79.00	<3
10/2/2006	LS9	7.0	<500	16.4	<300	0.00	95.00	<3
10/10/2006	LS9	6.5	<500	17.0	<300	0.00	111.00	<3
10/25/2006	LS9	7.0	<500	15.0	<300	0.00	108.00	<3
AVG		**6.8**	**<0.5**	**12.5**	**417.3**	**4.3**	**86.5**	
6/26/2002	LS11	6.6	743.00	19.4	3120.00	0.00	1920.00	<3
7/26/2002	LS11	6.7	684.00	28.0	3560.00	0.00	2400.00	6
8/20/2002	LS11	6.6	<500.00	24.0	4380.00	0.00	2930.00	22
11/25/2002	LS11	6.5	645.00	15.2	1570.00	0.00	816.00	
1/7/2003	LS11	6.7	558.00	12.8	1390.00	0.00	778.00	6
3/27/2003	LS11	6.6	668.00	13.2	1230.00	44.20	614.00	10
4/30/2003	LS11	6.4	686.00	16.8	1960.00	38.60	1320.00	<3
6/3/2003	LS11	6.5	749.00	12.8	1200.00	0.00	543.00	8
5/27/2004	LS11	6.3	646.00	18.0	1660.00	51.80	887.00	<3
AVG		**6.5**	**653.2**	**17.8**	**2230.0**	**15.0**	**1356.4**	
5/31/2006	LSNR	7.0	<500	20.8	567.00	10.40	508.00	<3
7/24/2006	LSNR	7.4	<500	23.2	317.00	0.00	1110.00	12
8/28/2006	LSNR	7.2	<500	23.0	1150.00	0.00	766.00	<3
10/26/2006	LSNR	7.1	<500	17.6	<300	0.00	632.00	<3
AVG		**7.2**		**21.2**	**678.0**	**2.6**	**754.0**	
6/26/2002	LS13	7.0	<500.00	16.6	300.00	0.00	114.00	<3
7/26/2002	LS13	7.6	<500.00	17.6	300.00	0.00	50.00	<3
8/20/2002	LS13	6.8	<500.00	16.8	300.00	0.00	50.00	4

11/25/2002	LS13	7.1	<500.00	15.6	300.00	0.00	320.00	8
1/7/2003	LS13	7.1	<500.00	12.8	300.00	0.00	338.00	<3
3/27/2003	LS13	6.5	<500.00	13.6	335.00	48.60	320.00	<3
4/30/2003	LS13	6.6	<500.00	13.0	300.00	0.00	453.00	<3
6/3/2003	LS13	6.8	<500.00	13.4	635.00	0.00	280.00	16
5/27/2004	LS13	6.6	1290.00	18.6	1920.00	48.60	376.00	8
5/31/2006	LS13	7.0	<500	19.6	559.00	0.00	498.00	<3
7/24/2006	LS13	6.3	<500	22.6	<300	0.00	601.00	4
8/28/2006	LS13	7.2	<500	22.4	680.00	0.00	680.00	4
10/26/2006	LS13	7.1	<500	16.4	<300	0.00	149.00	<3
AVG		**6.9**		**16.8**	**524.9**	**7.5**	**325.3**	

*Less than detects are calculated at the detection limit in the data sets.

Calculated flow using the unit area ratio method

Sampling Point	Area (unitless)	Adjusted flow, GPM	Adjusted flow, MGD
LS1		1500	2.16
LS2		1500	2.16
LS3	2832114.23030	3999.524755	5.759315647
LS4	4235677.92020	4494.877887	6.472624157
LS5	14247037.27596	8028.139859	11.5605214
LS6	40027387.14130	17126.67749	24.66241558
LS7	53217364.23738	21781.75407	31.36572586
LS8	110588753.68956	39029.56871	56.20257895
LS9	111646547.89294	39402.89105	56.74016311
LS11	170791045.05994	68316.49	98.4
LSNR	263038607.59031	100888.89	145.28
LS13	355286170.12067	133444.44	192.16

- Flow data for points LS1 and LS2 were estimated based on their relative contributions to the Little Schuylkill River at LS3.
- Flow at LS11 was measured by USGS, downstream points were then adjusted based on previously calculated unit area ratios

Attachment J

Comment and Response

Comment:

The Draft Revised LSR TMDL relies on the pending drafts of revisions to the Panther Creek TMDL and the NPDES permit for the LCN Mine, both of which are flawed for the reasons earlier explained by PennFuture and incorporated herein.

Response:

The Department agrees that the revised Little Schuylkill TMDL incorporates assumptions regarding approval of a revised Panther Creek TMDL. The WLAs assigned in the TMDL, though consistent with the draft NPDES permit, were derived independent of the NPDES permit

Comment:

The "measured" pollutant concentrations for monitoring station LS11 in Table C22 do not match the water quality data for monitoring station LS11 in Appendix I.

Response:

Thank you for pointing out the error(s) in the calculation of LS11 existing loads. It was caused by a combination of the "less than detect" being set to zero instead of the detection limit and also by the averaging formula in EXCEL incorrectly specifying range.

Comment:

If the Department uses PENTOXSD for one mine drainage metal, it must use PEXTOXSD for all of them.

Response:

The TMDL did not calculate the effluent limitations in the NPDES permit. As acknowledged previously, approval of the Panther Creek TMDL is dependent upon approval of the Little Schuylkill TMDL.