WILSON CREEK WATERSHED TMDL
Lackawanna County

Prepared for:

Pennsylvania Department of Environmental Protection

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INTRODUCTION

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Wilson Creek Watershed (Attachment A). It was done to address the impairments noted on the 1996, 1998, 2002, and draft 2004 Pennsylvania Section 303(d) lists and required under the Clean Water Act. The TMDL covers one segment on these lists (Table 1). High levels of metals, and depressed pH caused these impairments. All impairments resulted from abandoned mine drainage (AMD) from coal mining. The TMDL addresses the three primary metals (iron, manganese, and aluminum) associated with AMD and pH.

Table 1. Wilson Creek Segments Addressed

State Water Plan (SWP) Subbasin: 05-A Lackawanna River								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	0.6	Not placed on GIS	28595	Wilson Creek	CWF	305(b) Report	RE	pH, Metals
1998	0.6	4249	28595	Wilson Creek	CWF	305(b) Report	AMD	pH, Metals
2002	4.0	981021-0930-EPK	28595	Wilson Creek	CWF	SWAP	AMD	pH, Metals
2004	4.0	981021-0930-EPK	28595	Wilson Creek	CWF	SWAP	AMD	pH, Metals

Attachment B includes a justification of differences between the 1996, 1998, 2002, and draft 2004 303(d) lists.

CWF = Cold Water Fishes
RE = Resource Extraction
AMD = Abandoned Mine Drainage
SWAP = Surface Water Assessment Program

LOCATION

The Wilson Creek Watershed is approximately 3.8 square miles in area. It is located in the Lackawanna River Watershed in Lackawanna County. The stream originates from a pond west of Richmondale, Fell Township, and it drains into the Lackawanna River at Simpson, Pennsylvania. Wilson Creek flows 4 miles south from its headwaters to its confluence with the Lackawanna River. It can be accessed by traveling north on Rt. 6 to Carbondale and then north on Rt. 171 through Simpson.

[1] Pennsylvania's 1996, 1998, and 2002 lists were approved by the U.S. Environmental Protection Agency (USEPA). The 2004 Section 303(d) list was not yet approved at the time this document was written. The 1996 Section 303(d) list provides the basis for measuring progress under the 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

SEGMENTS ADDRESSED IN THIS TMDL

The Wilson Creek Watershed is affected by pollution from AMD. This pollution has caused high levels of metals and low pH throughout the stream. The majority of AMD degradation is due to three discharges entering Wilson Creek in a northern residential section of Simpson. Further upstream, there is also a section of the stream where culm piles make up some of the streambank.

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 U.S. Environmental Protection Agency’s (USEPA) implementing regulations (40 CFR 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 USEPA 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 nonpoint sources; and

- USEPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

Despite these requirements, states, territories, authorized tribes, and USEPA have not developed many TMDLs since 1972. Beginning in 1986, organizations in many states filed lawsuits against the USEPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While USEPA 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 USEPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., AMD, implementation of nonpoint source Best Management

Practices, 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 USEPA, the states have developed methods for assessing the waters within their respective jurisdictions.

The primary method adopted by the Pennsylvania Department of Environmental Protection (Pa. DEP) for evaluating waters changed between the publication of the 1996 and 1998 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. Pa. DEP is now using the Unassessed Waters Protocol (UWP), a modification of the USEPA Rapid Bioassessment Protocol II (RPB-II), as the primary mechanism to assess Pennsylvania's waters. The UWP 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 include 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 303(d) list with the documented source and cause. A TMDL must be developed for the stream segment. A TMDL is for only one pollutant. If a stream segment is impaired by two pollutants, two TMDLs must be developed for that stream segment. 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.);

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

2. Calculate TMDL for the waterbody using USEPA approved methods and computer models;
3. Allocate pollutant loads to various sources;
4. Determine critical and seasonal conditions;
5. Submit draft report for public review and comments; and
6. USEPA approval of the TMDL.

This document will present the information used to develop the Wilson Creek Watershed TMDL.

WATERSHED BACKGROUND

The Wilson Creek Watershed lies within the Appalachian Mountain Section of the Ridge and Valley Province. There is a decrease in elevation in the watershed of about 600 feet from its headwaters to its mouth. Wilson Creek is a tributary to the Lackawanna River. The Lackawanna River Watershed is characterized by long ridges with steep hillsides separated by valleys. Wilson Creek Watershed has similar characteristics, but on a much smaller scale. The upland areas have rocky, poorly drained soils. The remainder of the watershed has rapid permeability. The watershed is primarily forested (84 percent). However, the remainder of the land use is a mixture of abandoned mine lands, developed land, and open fields. Most of the development in the watershed is located near the mouth. Interbedded sedimentary rock and sandstone comprise the major rock types in the watershed (53 percent and 47 percent, respectively).

Underground mining of anthracite coal began in the Lackawanna River Watershed in the 1820s. Mining of the Northern Anthracite Coalfield took place down the center of this watershed from Forest City to Pittston. Thirteen coal beds of the anthracite field were mined. Most deep mines were forced to close in the late 1950s when the price of mining underground exceeded the price per ton of anthracite coal. The Knox Mine Disaster also contributed to the mine closings. In 1959, the Susquehanna River broke through at Pittston and flooded all of the underground mines in the lower Lackawanna and the Wyoming Valley. The last underground mine operation closed in 1966. Coal mining then shifted to surface mining in the 1960s. Since the 1960s, only minor strip mining and coal reprocessing have occurred (Lackawanna River Watershed Conservation Plan, 2001). There currently are no active mining permits within the Wilson Creek Watershed.

The Lackawanna River Watershed, which includes Wilson Creek, has been part of numerous studies that address its water quality problems such as AMD, urban/stormwater runoff, and combined sewer overflows (CSOs). This TMDL only addresses the AMD impairments to Wilson Creek. Some of the studies include: two Scarlift reports; a Lackawanna River Priority Water Body Survey conducted by the Susquehanna River Basin Commission; two U.S Army Corps of Engineers (USACE) reports: Lackawanna River Corridor Greenway Reconnaissance Report and Upper Susquehanna-Lackawanna River Watershed Section 206 Ecosystem Restoration Report (ERR); and a Lackawanna River Watershed Conservation Plan.

- The Lackawanna River Priority Water Body Survey was conducted in 1988. The Pa. Department of Environmental Resources (Pa. DER), Bureau of Water Quality Management, classified the river as a priority waterbody through a screening process that determined several water quality parameters to be a concern in the watershed. Water chemistry and physical characteristic data were collected during this survey. Three sewage treatment plants and two mine discharges were found to have the greatest impacts on the water quality of the river.

- The Lackawanna River Corridor Greenway Reconnaissance Report documented all sources of pollution in the watershed, including AMD. It identified AMD sources as well as recommended restoration solutions. The Phase I GIS Environmental Master Plan of the ERR mentioned above was conducted by the PA GIS Consortium and submitted to the USACE in 2001. The study used Geographic Information Systems (GIS) to inventory available environmental data for the watershed. Using GIS, environmental problems and their solutions were identified.

- The Lackawanna River Corridor Association developed a conservation plan for the watershed in partnership with 26 municipalities and Lackawanna County. The plan inventoried and examined environmental conditions of the watershed and offered recommendations for educational outreach, recreation, and conservation projects, and watershed management. Funding and support for this project came from federal, state and local entities, as well as the community.

AMD Methodology

A two-step approach is used for the TMDL analysis of AMD 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.

The statistical analysis described below can be applied to situations where all of the pollutant loading is from nonpoint sources, as well as those where there are both point and nonpoint sources. The following defines what are considered point sources and nonpoint sources for the purposes of our evaluation: point sources are defined as permitted discharges or a discharge that has a responsible party, nonpoint sources are then any pollution sources that are not point sources. For situations where all of the impact is due to nonpoint 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 nonpoint 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 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

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

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.

For pH TMDLs, acidity is compared to alkalinity as described in the following section. 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 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 from AMD may not be 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. The endpoint is based on either the narrative or numeric criteria available in water quality standards.

Because of the nature of the pollution sources in the watershed, the TMDLs component makeup will be load allocations that are specified above a point in the stream segment. All allocations will be specified as long-term average daily concentrations. These long-term average daily concentrations are expected to meet water quality criteria 99 percent of the time. Pennsylvania Title 25 Chapter 96.3(c) specifies that the water quality standards must be met 99 percent of the time. The iron TMDLs are expressed at total recoverable as the iron data used for this analysis were reported as total recoverable. Table 2 shows the water quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria

Parameter	Criterion Value (mg/l)	Total Recoverable/Dissolved
Aluminum (Al)	0.75	Total Recoverable
Iron (Fe)	1.50 0.3	30-Day Average Total Recoverable Dissolved
Manganese (Mn)	1.00	Total Recoverable
pH *	6.0-9.0	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)

A TMDL equation consists of a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the portion of the load assigned to point sources. The LA is the portion of the load assigned to nonpoint sources. The MOS is applied to account for uncertainties in the computational process. The MOS may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

TMDL ALLOCATIONS SUMMARY

There were not enough paired flow/parameter data to calculate correlations (fewer than 10 paired observations) in this TMDL.

Methodology for dealing with metal and pH impairments is discussed in Attachment C. Information for the TMDL analysis using the methodology described above is contained in the TMDLs by segment section in Attachment D.

This TMDL will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDL may be reevaluated to reflect current conditions. Table 3 presents the estimated reductions identified for all points in the watershed. Attachment D gives detailed TMDLs by segment analysis for each allocation point.

Table 3. Summary Table–Wilson Creek Watershed

Station	Parameter	Existing Load (lb/day)	TMDL Allowable Load (lb/day)	WLA (lb/day)	LA (lb/day)	Load Reduction (lb/day)	Percent Reduction %
WC3							
	Fe	ND	NA	0.0	NA	0	0
	Mn	ND	NA	0.0	NA	0	0
	Al	ND	NA	0.0	NA	0	0
	Acidity	133.8	29.4	0.0	NA	104.4	78
WC2							
	Fe	ND	NA	0.0	NA	0	0
	Mn	ND	NA	0.0	NA	0	0
	Al	ND	NA	0.0	NA	0	0
	Acidity	110.2	51.5	0.0	51.5	58.7*	53*
WC1							
	Fe	ND	NA	0.0	NA	0	0
	Mn	ND	NA	0.0	NA	0	0
	Al	ND	NA	0.0	NA	0	0
	Acidity	5.2	20.6	0.0	20.6	0*	0*

ND = not detected; NA = meets water quality standards, no TMDL necessary
* = calculated using mass balance with upstream point(s); see Tables D3 and D5 for calculations

RECOMMENDATIONS

In the late 1990s, the Lackawanna River Watershed 2000 Program was developed from a USEPA water resources grant. The intent of the grant is to address AMD, abandoned mine lands, and CSO problems in the watershed. A working partnership was developed between state and local agencies, as well as a working group that meets to discuss current and future projects in the watershed.

Two primary programs that provide reasonable assurance for maintenance and improvements of water quality in the watershed are in effect. The Pa. DEP's efforts to reclaim AMLs, 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 Pa. DEP's Bureau of Abandoned Mine Reclamation (BAMR), which administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania, the U. S. Office of Surface Mining, the National Mine Land Reclamation Center, the National Environmental Training Laboratory, and many other agencies and individuals. Funding from USEPA's 319 Nonpoint Source Program, and Pennsylvania's Growing Greener Program has been used extensively to remedy mine drainage impacts. These many activities are expected to continue and result in water quality improvement.

Reclaim PA is Pa. DEP's initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Abandoned mineral extraction lands in Pennsylvania constitute a significant public liability - more than 250,000 acres of abandoned surface mines, 2,400 miles of stream polluted with AMD, over 7,000 orphaned and abandoned oil and gas wells, widespread subsidence problems, numerous hazardous mine openings, mine fires, abandoned structures, and affected water supplies–representing as much as one-third of the total problem nationally.

Since the 1960s, Pennsylvania has been a national leader in establishing laws and regulations to ensure mine reclamation and well plugging occur after active operation is completed. Mine reclamation and well plugging refers to the process of cleaning up environmental pollutants and safety hazards associated with a site and returning the land to a productive condition, similar to Pa. DEP's Brownfields Program. Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphan wells. Realizing this task is no small order, Pa. DEP has developed Reclaim PA, a collection of concepts to make abandoned mine reclamation easier. These concepts include legislative, policy, and land management initiatives designed to enhance mine operator/volunteer/Pa. DEP reclamation efforts. Reclaim PA has the following four objectives:

- To encourage private and public participation in abandoned mine reclamation efforts.
- To improve reclamation efficiency through better communication between reclamation partners.
- To increase reclamation by reducing remining risks.
- To maximize reclamation funding by expanding existing sources and exploring new sources.

The coal industry, through Pa. DEP-promoted remining efforts, can help to eliminate some sources of AMD and conduct some of the remediation through the permitting, mining, and reclamation of abandoned and disturbed mine lands. Special consideration should be given to potential remining projects within these areas as the environmental benefit versus cost ratio is generally very high.

PUBLIC PARTICIPATION

In the beginning stages of the Wilson Creek Watershed TMDL, an early notification letter was sent to inform stakeholders and interested parties that a TMDL would be completed in their watershed and offer them the opportunity to submit information for TMDL development. The PADEP considered all the information submitted and all pertinent information was included in the report.

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on January 8, 2005, and the Scranton Times on January 19, 2005 to foster public comment on the allowable loads calculated. A public meeting was held on January 25, 2005, at the Dickson City Borough Hall in Dickson City to discuss the proposed TMDL.

REFERENCES

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McMorran, Carl P. 1989. Lackawanna River Priority Water Body Survey Report Water Quality Standards Review. Susquehanna River Basin Commission. Publication No. 124.

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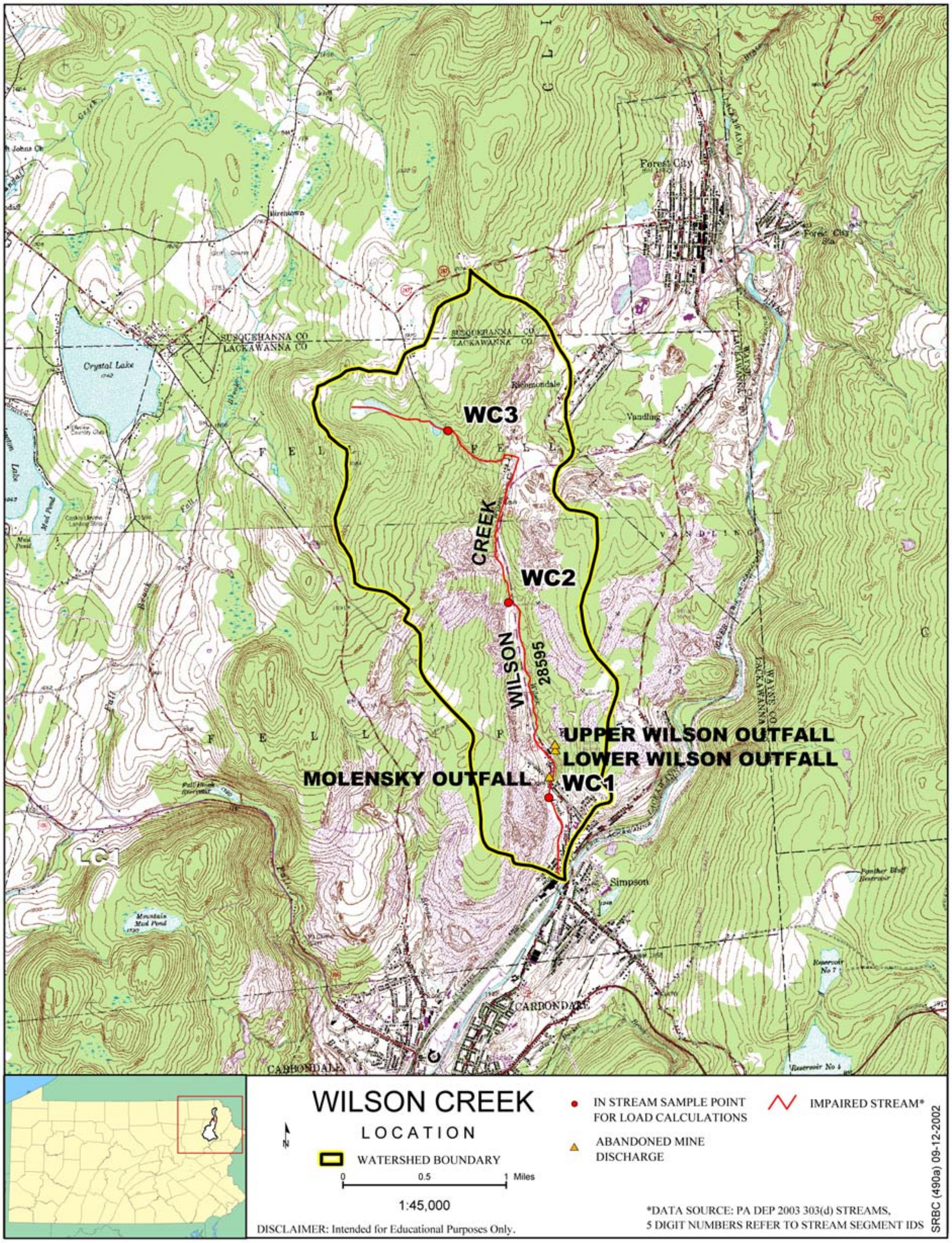
United States Army Corps of Engineers. 1993. Lackawanna River Corridor Greenway Reconnaissance Report.

Attachment A

Wilson Creek Watershed Map


WC3
CREEK
WC2
WILSON
28595
UPPER WILSON OUTFALL
LOWER WILSON OUTFALL
MOLENSKY OUTFALL
WC1
LC1
Forest City
Crystal Lake
Simpson
CARBONDALE
SUSQUEHANNA CO
LACKAWANNA CO
WILSON CREEK
LOCATION
WATERSHED BOUNDARY
0
0.5
1 Miles
1:45,000
IN STREAM SAMPLE POINT FOR LOAD CALCULATIONS
ABANDONED MINE DISCHARGE
IMPAIRED STREAM*
*DATA SOURCE: PA DEP 2003 303(d) STREAMS,
5 DIGIT NUMBERS REFER TO STREAM SEGMENT IDS
DISCLAIMER: Intended for Educational Purposes Only.
SRBC (490a) 09-12-2002

Attachment B

Excerpts Justifying Changes Between the 1996, 1998, Draft 2000, 2002, and Draft 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, draft 2000, 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 USEPA 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).

The most notable difference between the 1998 and Draft 2000 303(d) lists are the listing of unnamed tributaries in 2000. In 1998, the GIS stream layer was coded to the named stream level so there was no way to identify the unnamed tributary records. As a result, the unnamed tributaries were listed as part of the first downstream named stream. The GIS stream coverage used to generate the 2000 list had the unnamed tributaries coded with the Pa. DEP's five-digit stream code. As a result, the unnamed tributary records are now split out as separate records on the 2000 303(d) list. This is the reason for the change in the appearance of the list and the noticeable increase in the number of pages. After due consideration of comments from USEPA and Pa. DEP on the Draft 2000 Section 303(d) list, the 2002 Pa. Section 303(d) list was written in a manner similar to the 1998 Section 303(d) list.

In 2004, Pennsylvania developed the Draft Integrated List of All Waters. The water quality status of Pennsylvania's waters is summarized using a five-part categorization of waters according to their water quality standard (WQS) attainment status. The categories represent varying levels of WQS attainment, ranging from Category 1, where all designated water uses are met, to Category 5, where impairment by pollutants requires a TMDL to correct. These category determinations are based on consideration of data and information consistent with the methods outlined by the Statewide Surface Water Assessment Program. Each Pa. DEP five-digit waterbody segment is placed in one of the WQS attainment categories. Different segments of the same stream may appear on more than one list if the attainment status changes as the water flows downstream. The listing categories are as follows:

Category 1: Waters attaining all designated uses.

Category 2: Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize a water consistent with the state's listing methodology.

Category 3: Waters for which there are insufficient or no data and information to determine, consistent with the state's listing methodology, if designated uses are met.

Category 4: Waters impaired for one or more designated use but not needing a TMDL. States may place these waters in one of the following three subcategories:

- Category 4A: TMDL has been completed.
- Category 4B: Expected to meet all designated uses within a reasonable timeframe.
- Category 4C: Not impaired by a pollutant.

Category 5: Waters impaired for one or more designated uses by any pollutant. Category 5 includes waters shown to be impaired as the result of biological assessments used to evaluate aquatic life use even if the specific pollutant is not known unless the state can demonstrate that nonpollutant stressors cause the impairment or that no pollutant(s) causes or contribute to the impairment. Category 5 constitutes the Section 303(d) list that USEPA will approve or disapprove under the Clean Water Act. Where more than one pollutant is causing the impairment, the water remains in Category 5 until all pollutants are addressed in a completed USEPA-approved TMDL or one of the delisting factors is satisfied.

Attachment C

Method for Addressing 303(d) Listings for pH

Method for Addressing 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 USEPA's acceptable range of six to nine and meets Pennsylvania water quality criteria in Pa. Code, 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 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 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. 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 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 meet a minimum net alkalinity of zero.

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.*

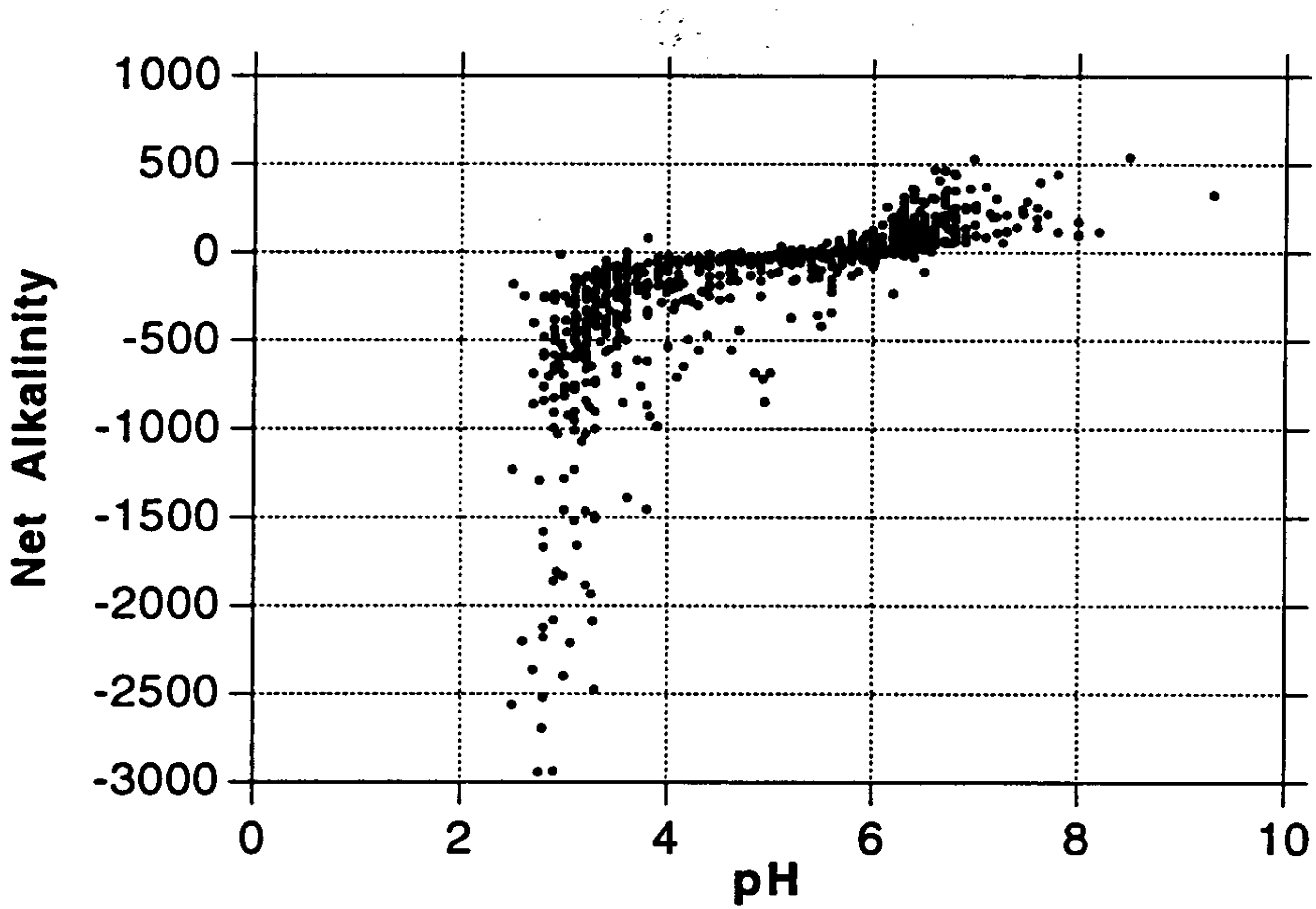


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

Attachment D
TMDLs By Segment

Wilson Creek above WC3

Wilson Creek above WC3 represents all of Wilson Creek upstream of this point. The Wilson Creek Watershed has been greatly impacted by previous mining operations. Culm piles and strip pits are scattered throughout the watershed. In some areas the stream comes into contact with these abandoned mine lands (AMLs); however, above point WC3 there is little impact from AMLs to the stream (Lackawanna River Conservation Plan, 2001).

The TMDL for this section of Wilson Creek consists of a load allocation to all of the watershed area above point WC3. Addressing the causes of high acidity above this point, such as coniferous forests and sandstone geology with little buffering capacity, addresses the impairment. Load reductions for acidity were calculated using the instream average alkalinity as the water quality standard for acidity at point WC3. An instream flow measurement was available for point WC3 (0.77 mgd).

The iron concentration on all samples except one was below the detection limit of 0.30 mg/l, with the one concentration above the detection limit being below water quality standards (1.5 mg/l) for iron; therefore, it can be assumed that the segment is not impaired by iron. Manganese concentrations were below the detection limit of 0.050 mg/l for all but two samples which had concentrations below water quality standards for manganese (1.0 mg/l); therefore, it can be assumed that the segment is not impaired by manganese. Aluminum concentrations were below the detection limit of 0.500 mg/l for all samples; therefore, it can be assumed that the segment is not impaired by aluminum. Because there were fewer than four data points with sample concentrations above detection limits, Monte Carlo simulation was not conducted for iron, manganese, and aluminum for point WC3.

An allowable long-term average instream concentration was determined at point WC3 for acidity. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent 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 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 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 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at WC3 for this stream segment are presented in Table D1.

Table D1. Reductions for Wilson Creek at WC3					
Station WC3	***Measured Sample Data***		***Allowable***		***Reduction Identified***
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Fe	ND	ND	NA	NA	0
Mn	ND	ND	NA	NA	0
Al	ND	ND	NA	NA	0
Acidity	20.83	133.8	4.58	29.4	78
Alkalinity	13.20	84.8			

All values shown in this table are long-term average daily values.
ND = not detected; NA = meets water quality standards, no TMDL necessary

The TMDL for Wilson Creek at point WC3 requires that a load allocation be applied to Wilson Creek above WC3 for acidity.

Wilson Creek between WC3 and WC2

Wilson Creek at WC2 represents all of the watershed area between WC3 and WC2. This section of the stream flows through AMLs. One major AML feature called the Richmondale Pile is located about a half mile downstream of point WC3 and southwest of Richmondale. At the Richmondale Pile, the stream flows through waste rock piles and strip pits. More waste rock piles can be found further downstream to point WC2 (Lackawanna River Conservation Plan, 2001).

The TMDL for this section of Wilson Creek consists of a load allocation to all of the watershed area between WC3 and WC2. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point WC2 (2.45 mgd). Load reductions for acidity were calculated using the instream average alkalinity as the water quality standard for acidity at point WC2.

The iron concentration in all samples was below the detection limit of 0.300 mg/l; therefore, it can be assumed that the segment is not impaired by iron. Manganese concentrations were below the detection limit of 0.050 mg/l for all samples; therefore, it can be assumed that the segment is not impaired by manganese. Aluminum concentrations were below the detection limit of 0.500 mg/l for all samples; therefore, it can be assumed that the segment is not impaired by aluminum. Because there were fewer than four data points with sample concentrations above detection limits, Monte Carlo simulation was not conducted for iron, manganese, and aluminum for point WC2.

An allowable long-term average instream concentration for acidity was determined at point WC2. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent 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 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 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 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point WC2 for this stream segment are presented in Table D2.

Table D2. Long Term Average (LTA) Concentrations for Wilson Creek at WC2

Station WC2	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	ND	ND	NA	NA
Mn	ND	ND	NA	NA
Al	ND	ND	NA	NA
Acidity	10.50	214.6	2.52	51.5
Alkalinity	10.75	219.7		

All values shown in this table are long-term average daily values.
ND = not detected; NA = meeting water quality standards, no TMDL necessary

The loading reduction for point WC3 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point WC2. This value was compared to the allowable load at point WC2. Reductions at point WC2 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point WC2 are shown in Table D3.

Table D3. Reductions Necessary at Point WC2

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Load at WC2	ND	ND	ND	214.6
Existing load from upstream points (WC3)	-	-	-	133.8
Difference of existing load and upstream existing load	-	-	-	80.8
Percent load loss due to instream process	-	-	-	0
Allowable loads from upstream point	-	-	-	29.4
Percent remaining at WC2	-	-	-	100
Total Load at WC2	-	-	-	110.2
Allowable Loads at WC2	NA	NA	NA	51.5
Load reduction at WC2 (Total load at WC2 – Allowable load at WC2)	0.0	0.0	0.0	58.7
Percent reduction required at WC2	0	0	0	53

The TMDL for point WC2 requires that a load allocation be applied to all areas of Wilson Creek between WC3 and WC2 for acidity.

Wilson Creek between WC2 and WC1

Wilson Creek at WC1 represents all of the watershed area between WC2 and WC1. There are three abandoned mine discharges in this section of Wilson Creek. The Upper Wilson Outfall is located behind houses in a residential area; it was caused by a roof drop that occurred near the outcrop of a coal vein. The Lower Wilson Outfall is a few yards downstream of the Upper Wilson Outfall. Mine water discharges from a collapsed drift opening on the north bank of the stream. The Molensky Slope Outfall, located several yards downstream of the Rt. 171 bridge, discharges into Wilson Creek from a slope draining the underground mines. At this point in the stream, most of the flow in Wilson Creek comes from the Molensky discharge (Lackawanna River Conservation Plan, 2001).

The TMDL for this section of Wilson Creek consists of a load allocation to all of the watershed area between WC2 and WC1. Addressing the mining impacts between these points addresses the impairment for the segment. An instream flow measurement was available for point WC1 (9.89 mgd). Load reductions for acidity were calculated using the instream average alkalinity as the water quality standard for acidity at point WC1.

The iron concentration of all samples except two were below the detection limit of 0.300 mg/l, with the two concentrations above the detection limit being below water quality standards (1.5 mg/l) for iron; therefore, it can be assumed that the segment is not impaired by iron. Manganese concentrations were below the detection limit of 0.050 mg/l for all but two samples which had concentrations below water quality standards for manganese (1.0 mg/l); therefore, it can be assumed that the segment is not impaired by manganese. Aluminum concentrations were below the detection limit of 0.500 mg/l for all but two samples which had concentrations below water quality standards for aluminum (0.75 mg/l); therefore, it can be assumed that the segment is not impaired by aluminum. Because there were fewer than four data points with sample concentrations above detection limits, Monte Carlo simulation was not conducted for iron, manganese, and aluminum for point WC1.

An allowable long-term average instream concentration for acidity was determined at point WC1. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent 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 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 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 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point WC1 for this stream segment are presented in Table D4.

Table D4. Long Term Average (LTA) Concentrations for Wilson Creek at WC1				
Station WC1	***Measured Sample Data***		***Allowable***	
	Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
Fe	ND	ND	NA	NA
Mn	ND	ND	NA	NA
Al	ND	ND	NA	NA
Acidity	0.25	20.6	0.25	20.6
Alkalinity	37.00	3,051.9		

All values shown in this table are long-term average daily values.
ND = not detected; NA = meeting water quality standards, no TMDL necessary

The loading reductions for points WC3 and WC2 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point WC1. This value was compared to the allowable load at point WC1. Reductions at point WC1 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point WC1 are shown in Table D5.

The calculated load reductions for all the loads that enter point WC1 must be accounted for in the calculated reductions at sample point WC1 shown is Table D5. A comparison of measured loads between points WC2 and WC3 shows that there is additional loading entering the segment for iron, manganese and aluminum and a loss in load for acidity indicated by the negative numbers in the second row of Table D5. A loss in load indicates that instream processes, such as settling, are taking place within the segment. It also indicates that no additional loading is directly entering the segment for acidity. To determine the total segment load, the percent decrease in existing loads between WC2 and WC1 is applied to the upstream loads entering the segment. For acidity, the allowable load at WC1 is less than the upstream loads entering the segment, which results in a load reduction for the segment. It is assumed that once allocations at upstream points are met, the TMDL at WC1 also will be met.

Table D5. Reductions Necessary at Point WC1				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Load at WC1	ND	ND	ND	20.6
Existing load from upstream points (WC2)	-	-	-	214.6
Difference of existing load and upstream existing load	-	-	-	-194.0
Percent load loss due to instream process	-	-	-	90
Allowable loads from upstream point	-	-	-	51.5
Percent remaining at WC1	-	-	-	10
Total Load at WC1	-	-	-	5.2
Allowable Loads at WC1	NA	NA	NA	20.6
Load reduction at WC1 (Total load at WC1 – Allowable load at WC1)	0.0	0.0	0.0	0.0
Percent reduction required at WC1	0	0	0	0

The TMDL for point WC1 does not require that a load allocation be applied to all areas of Wilson Creek between WC2 and WC1.

Margin of Safety (MOS)

Pa. DEP used an implicit MOS in these TMDLs derived from the Monte Carlo statistical analysis. The Water Quality Standards state that water quality criteria must be met at least 99 percent of the time. All of the @Risk analyses results surpass the minimum 99 percent level of protection. Another MOS used for this TMDL analyses 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 MOS.
- 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 E

Water Quality Data Used
In TMDL Calculations

TMDL Site	Study Point	Company	Permit	Date	Flow (gpm)	Acid mg/l	Alk mg/l	Fe mg/l	Mn mg/l	Al mg/l	pH
WC3	WILS3.0	SRBC-604(b) Report	*	1/8/2002	285.46	18.6	13.2	<0.300	<0.050	<0.500	5.8
	WILS3.0	SRBC-604(b) Report	*	2/12/2002	1131.95	31	10.4	<0.300	<0.050	<0.500	6.2
	WILS3.0	SRBC-604(b) Report	*	3/25/2002	371.9	26.6	12.8	<0.300	<0.050	<0.500	5.9
	WILS3.0	SRBC-604(b) Report	*	5/1/2002	1043.71	21	11.2	<0.300	<0.050	<0.500	6.1
	WILS3.0	SRBC-604(b) Report	*	6/12/2002	299.1	27.8	13.8	0.387	0.064	<0.500	5.9
	WILS3.0	SRBC-604(b) Report	*	7/17/2002	72.85	0	17.8	<0.300	0.116	<0.500	6.7

Average=	534.16167	20.833333	13.2	0.387	0.09	<0.500	6.1
StDev=	441.18799	11.173123	2.5892084	*	0.0367696	*	0.3286335

TMDL Site	Study Point	Company	Permit	Date	Flow (gpm)	Acid mg/l	Alk mg/l	Fe mg/l	Mn mg/l	Al mg/l	pH
WC2	WILS2.0	SRBC-604(b) Report	*	1/8/2002	DRY	*	*	*	*	*	*
	WILS2.0	SRBC-604(b) Report	*	2/12/2002	2552.95	22	8.6	<0.300	<0.050	<0.500	6.1
	WILS2.0	SRBC-604(b) Report	*	3/25/2002	525.99	7	9.8	<0.300	<0.050	<0.500	6.2
	WILS2.0	SRBC-604(b) Report	*	5/1/2002	3576.78	12.2	9.6	<0.300	<0.050	<0.500	6
	WILS2.0	SRBC-604(b) Report	*	6/12/2002	150.4	0.8	15	<0.300	<0.050	<0.500	5.6
	WILS2.0	SRBC-604(b) Report	*	7/17/2002	DRY	*	*	*	*	*	*

Average=	1701.53	10.5	10.75	<0.300	<0.050	<0.500	5.975
StDev=	1635.9887	8.9718077	2.8815505	*	*	*	0.2629956

TMDL Site	Study Point	Company	Permit	Date	Flow (gpm)	Acid mg/l	Alk mg/l	Fe mg/l	Mn mg/l	Al mg/l	pH
WC1	WLSN 0.5	SRBC-Lackawanna River Priority Water Body Survey Report	*	10/18/1988	2158.88	2	32	0.176	0.121	0.158	6.2
	WC mi. 30.8	Pa.DEP Wilkes Barre Water Quality Program	*	8/17/1991	*	0	32	0.012	0.0219	0.0141	6.9
	WILS1.0	SRBC-604(b) Report	*	1/8/2002	3456.45	0	36	<0.300	<0.050	<0.500	5.9
	WILS1.0	SRBC-604(b) Report	*	2/12/2002	12369.79	0	34	<0.300	<0.050	<0.500	6.4
	WILS1.0	SRBC-604(b) Report	*	3/25/2002	6018.69	0	38	<0.300	<0.050	<0.500	6.2
	WILS1.0	SRBC-604(b) Report	*	5/1/2002	11619.21	0	36	<0.300	<0.050	<0.500	6.3
	WILS1.0	SRBC-604(b) Report	*	6/12/2002	7753.56	0	44	<0.300	<0.050	<0.500	6
	WILS1.0	SRBC-604(b) Report	*	7/17/2002	4690.15	0	44	<0.300	<0.050	<0.500	6.4

Average=	6866.6757	0.25	37	0.094	0.07145	0.08605	6.2875
StDev=	3935.0294	0.7071068	4.7809144	0.1159655	0.0700743	0.1017527	0.3044316

"*" signifies no data were collected

Note: All concentrations are in units of milligrams per liter (mg/l); all discharge measurements are in units of gallons per minute (GPM).

Attachment F
Comment and Response

No Comments Received