LIMESTONE RUN WATERSHED
FINAL TMDL
Armstrong County

Prepared for:

Pennsylvania Department of Environmental Protection

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Introduction

This report presents the Total Maximum Daily Loads (TMDLs) developed for stream segments in the Limestone Run Watershed (Attachment A). These were done to address the impairments noted on the 1996 Pennsylvania Section 303(d) list of impaired waters, required under the Clean Water Act, and covers one segment on this list (shown in Table 1). The stream segment was put on the Section 303(d) list for other inorganics as the cause of impairment. All impairments resulted from acid drainage from abandoned coal mines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and other inorganics.

Table 1. 303(d) Sub-List

State Water Plan (SWP) Subbasin: 17-E Crooked Creek Basin

Year	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	Source	EPA 305(b) Cause Code
1996	5.2	5267	47105	Limestone Run	WWF	305(b) Report	RE	Other Inorganics
1998	5.6	5267	47105	Limestone Run	WWF	SWMP	AMD	Other Inorganics
2000	No additional assessment data collected for the 2000 303(d) list.			Limestone Run	WWF	SWMP	AMD	Other Inorganics
2002	No additional assessment data collected for the 2002 303(d) list.			Limestone Run	WWF	SWMP	AMD	Other Inorganics

Resource Extraction=RE
Warm Water Fishes=WWF
Surface Water Monitoring Program = SWMP
Abandoned Mine Drainage = AMD
See Attachment E, *Excerpts Justifying Changes Between the 1996, 1998 and Draft 2000 Section 303(d) Lists.*
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.

Directions to the Limestone Run Watershed

The main branch of Limestone Run is 5.6 miles long and is located in the Ohio River Watershed. It flows to the Allegheny River about 3.5 miles north of the city of Kittanning. The main branch and tributaries lay in the mostly rural East Franklin and Washington Townships of Armstrong County. The watershed is about 10.2 square miles. The stream enters the Allegheny River about

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[1] Pennsylvania's 1995 and 1998 Section 303(d) lists were approved by the Environmental Protection Agency (EPA). The 2000 Section 303(d) list was not required by U. S. Environmental Protection Agency. 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.*

one half a mile north of Tarrtown. The stream flows generally from NNE to SSE direction. The mouth of Limestone Run can be accessed by following State Road 4023 north from Kittanning to a point one half mile north of Tarrtown. The eastern border of the watershed follows Township Road T-480. The western border follows Township road T-476 north from Tarrtown, then north again along State Road 4019 to Township Road T-418. The northern border is Township Road T-438 east from Township Road T-419 in Washington Township. The town of Adrian lies in the middle of the watershed at the confluence of several tributaries. Limestone Run Watershed can be found by taking the PA Turnpike to the Harmarville Exit (Exit 5) to PA State Route 28 north to Kittaning, then north on State Road 4023 for 3.5 miles past Tarrtown.

Segments addressed in this TMDL

There are currently two active re-mining permits in the Limestone Watershed, Walter L. Houser Coal Co., Inc. SMP No. 03990107, which is currently mining, and State Ind. Inc., SMP No. 03970105, which has not yet started to mine. The locations of these mines can be found on the map in Appendix A. There will be no waste load allocations to these discharges because they are re-mining operations and all discharges are pre-existing. The pre-existing discharge effluent limitations are located in Table 2. Information about re-mining in Pennsylvania is located in Appendix H.

The reduction necessary to meet applicable water quality standards from preexisting conditions (including discharges from areas coextensive with areas permitted under the remining program Subchapter F or G) are expressed in the LA portion of the TMDL. The WLAs express the basis for applicable effluent limitations on point sources. Except for any expressed assumptions, any WLA allocated to a remining permittee does not require the permittee to necessarily implement the reductions from preexisting conditions set forth in the LA. Additional requirements for the permittee to address the preexisting conditions are set forth in the applicable NPDES/mining permit. The individual discharges are not assigned load allocations, however; discharge affects on the stream are taken into account at the closest downstream sampling point.

Table 2. Pre-Existing Discharge Effluent Limitations

Parameter	Monthly Average lbs/day	Instantaneous Maximum lbs/day
HU1 (State Ind., Inc.)		
Net Acidity	11.30	22.10
Iron	*	*
Manganese	2.12	4.20
Aluminum	0.78	1.28
HU2 (State Ind., Inc.)		
Net Acidity	0.19	0.45
Iron	*	*
Manganese	0.04	0.05
Aluminum	0.00	0.02

Table 2. Pre-Existing Discharge Effluent Limitations		
Parameter	Monthly Average lbs/day	Instantaneous Maximum lbs/day
MP4 (Walter Houser Coal Co., Inc.)		
Net Acidity	0.82	1.97
Iron	*	*
Manganese	0.05	0.18
Aluminum	0.08	0.27

* Under the provisions of 25 Pa. Code 87.207(b)/88.507(b), the permittee has elected to comply with the effluent limits established in 25 Pa. Code 87.102/88.92/88.187 instead of a loading limit. The effluent limits in 25 Pa. Code 87.102/88.92/88.187 shall apply at all times for this particular parameter.

The distinction between non-point and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge. Where there is no responsible party the discharge is considered to be a non-point source. Each segment on the Pennsylvania 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 gives a better representation of the data used for the calculations. See Attachment E 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 U.S. Environmental Protection Agency’s (USEPA) 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 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 (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 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 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. 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 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.

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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.

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 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.);
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.

Watershed History

Surface elevations for Limestone Run range from 780 feet at its mouth on the Allegheny to a high of 1430 feet. Stratigraphically, Limestone Run lies in the Allegheny Group of Pennsylvanian Age rocks. The Allegheny Group contains the majority of economically mineable coals in Pennsylvania. The Allegheny Group extends from the bottom of the Brookville coal to the top of the upper Freeport coal. Mines located in Jefferson, Armstrong, Indiana, Cambria, and Somerset Counties extract Allegheny Group coals. These mines generally lie along the perimeter of the bituminous coalfield where the coals outcrop and are easily accessible. The lithology is mainly shale and siltstone with minor amounts of sandstone. Structurally, the formations in this watershed are flat and no significant structural items occur. Mining data shows an eastern strike and southerly dip of 1 to 2 percent.

The Lower Freeport coal seam has been heavily mined by underground methods. The Upper Freeport has been mostly surfaced mined along with the Mahoning coal. Other coal seams include the Kittannings (Upper, Middle, & Lower) and the Clarion coal. Overburden is mostly alkaline throughout the watershed, which is evidenced by the fair water quality of assessed segments.

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% of the time. The iron TMDLs are expressed at total recoverable as the iron data used for this analysis was reported as total recoverable. The aluminum criterion is located in Pennsylvania Title 25 Chapter 16.102. The following table shows the 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 0.3	30-day average; Total Recoverable Dissolved
Manganese (Mn)	1.00	Total Recoverable
pH *	6.0-9.0	N/A
Sulfates	250	Total Recoverable

*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).

Other Inorganics

The cause of inorganic impairment as listed on the 1996 Section 303(d) list is sulfates. Due to Title 25 Chapter 96.3(d) a TMDL to address sulfates is not necessary. The nearest potable water withdrawal to Limestone Run occurs approximately 1 mile downstream of the mouth at the Kittanning Suburb JT Water Authority (#5030043) located on the Allegheny River. Limestone Run, with an average flow of 4.65 MGD, drains directly into the Allegheny River. A flow of 8224 MGD was calculated for the Allegheny River just upstream of Limestone Run using the unit area method and flow data from USGS Gage Station 03036500 located at Lock 7 of the Allegheny River near Kittanning. It was calculated that the concentration of sulfates in the Allegheny River upstream of Limestone Run would have to exceed 93.1 mg/L in order for sulfate criteria at the water supply intake to be exceeded. Measured data from WQN0802, located approximately 8 miles downstream of Limestone Run at the SR0128 Bridge in Ford City, has a ten-year average sulfate concentration of 42.8 mg/l. Conditions at the WQN are considered to be representative of the conditions just upstream of Limestone Run. This assumption is based on the minimal flow inputs between the two points, and the fact that some of the total sulfate load at the WQN station likely is from sources between the two points. Therefore it can be concluded that concentrations of sulfates do not exceed 93.1 mg/L just upstream of Limestone Run. The method and rationale for addressing sulfates is located in Appendix G. A map of the water supply intake, WQN Station, and USGS Gage Station is located in Appendix A and sulfate and flow data for the WQN stations is located in Appendix F.

TMDL Elements (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 nonpoint 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).

Allocation Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. Table 4 presents the estimated reductions identified for all points in the watershed. Attachment D gives detailed TMDLs by segment analysis for each allocation point.

Table 4. Summary Table–Limestone Run Watershed

Point	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
111		Limestone Run Downstream of Confluence w/ Trib. 47116				
	Al	0.02	0.3	0.02	0.3	0
	Fe	0.35	5.1	0.35	5.1	0
	Mn	1.48	21.2	0.38	5.5	74
112		Mouth of Tributary 47112				
	Al	0.41	2.6	0.10	0.7	75
	Fe	0.24	1.5	0.24	1.5	0
	Mn	0.57	3.7	0.29	1.9	49
113		Limestone Run Downstream of Confluence w/ Trib. 47112				
	Al	0.20	4.88	0.11	2.73	11
	Fe	0.82	20.08	0.49	12.05	40
	Mn	0.96	23.45	0.33	8.21	0
114		Limestone Run Downstream of Confluence w/ Trib. 47111				
	Al	0.02	0.5	0.02	0.5	0
	Fe	0.21	5.5	0.21	5.5	0
	Mn	0.61	15.6	0.29	7.5	0
115		Limestone Run Downstream of Confluence w/ Trib. 47108				
	Al	0.11	3.36	0.10	3.26	0
	Fe	0.23	7.28	0.23	7.28	0
	Mn	0.42	13.51	0.23	7.43	0
118		Limestone Run near Mouth				
	Al	0.06	2.32	0.06	2.32	0
	Fe	0.27	10.27	0.27	10.27	0
	Mn	0.46	17.73	0.14	5.50	0

Recommendations

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.

The PA DEP Bureau of Mining and Reclamation administers an environmental regulatory program for all mining activities, mine subsidence regulation, mine subsidence insurance, and coal refuse disposal; conducts a program to ensure safe underground bituminous mining and protect certain structures form subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives; provides for training, examination, and certification of applicants for blaster's licenses; and administers a loan program for bonding anthracite underground mines and for mine subsidence. Administers the EPA Watershed Assessment Grant Program, the Small Operator's Assistance Program (SOAP), and the Remining Operators Assistance Program (ROAP).

Reclaim PA is 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 constituted a significant public liability – more than 250,000 acres of abandoned surface mines, 2,400 miles of streams polluted with mine drainage, 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.

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 DEP's Brownfields program. Since the 1960's, Pennsylvania has been a national leader in establishing laws and regulations to ensure reclamation and plugging occur after active operation is completed.

Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphaned wells. Realizing this task is no small order, DEP has developed concepts to make abandoned mine reclamation easier. These concepts, collectively called Reclaim PA, include legislative, policy land management initiatives designed to enhance mine operator, volunteer land 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.

Acid mine drainage has had minor impact on Limestone Run. Current mining regulations along with the alkaline overburden have kept AMD to a minimum. Re-grading abandoned surface mines with alkaline addition would reduce AMD production. Passive treatment systems could also provide some solution to the AMD problem.

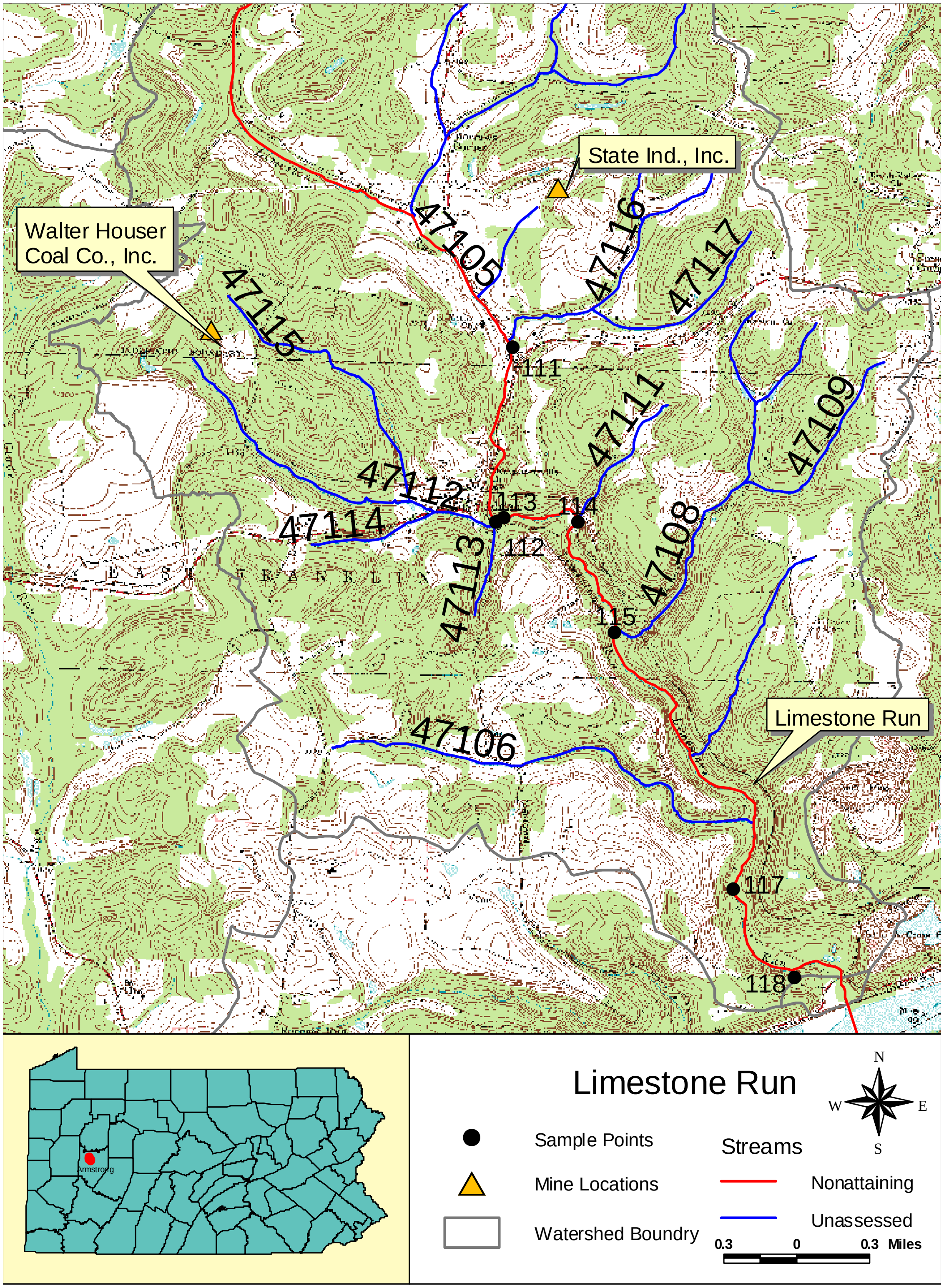
Allegheny Energy, the Armstrong County Conservation District, and the PA DEP, Bureau of Abandoned Mine Reclamation (BAMR) are in the process of designing a reclamation project in the Limestone Run Watershed. The project site is located near the town of Morrows Corner. The project area is an abandoned 45 acre surface mine site with 1,500 feet of open pit. Allegheny Energy plans to reclaim the site and backfill the open cut with a mixture of fly ash and lime. This would reduce AMD production from the site and thus improve the water quality in the Limestone Run Watershed. The project could take up to fifteen years to complete.

Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on December 21, 2002 and *The Leader Times* on January 06, 2003 to foster public comment on the allowable loads calculated. A public meeting was held on January 08, 2003 at 6 pm at the Armsdale Building in Kittanning, PA to discuss the proposed TMDL.

Attachment A

Limestone Run Watershed Map


State Ind., Inc.
Walter Houser Coal Co., Inc.
47105
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E A S T F R A N K L I N
Limestone Run
Armstrong
Limestone Run
Sample Points
Mine Locations
Watershed Boundry
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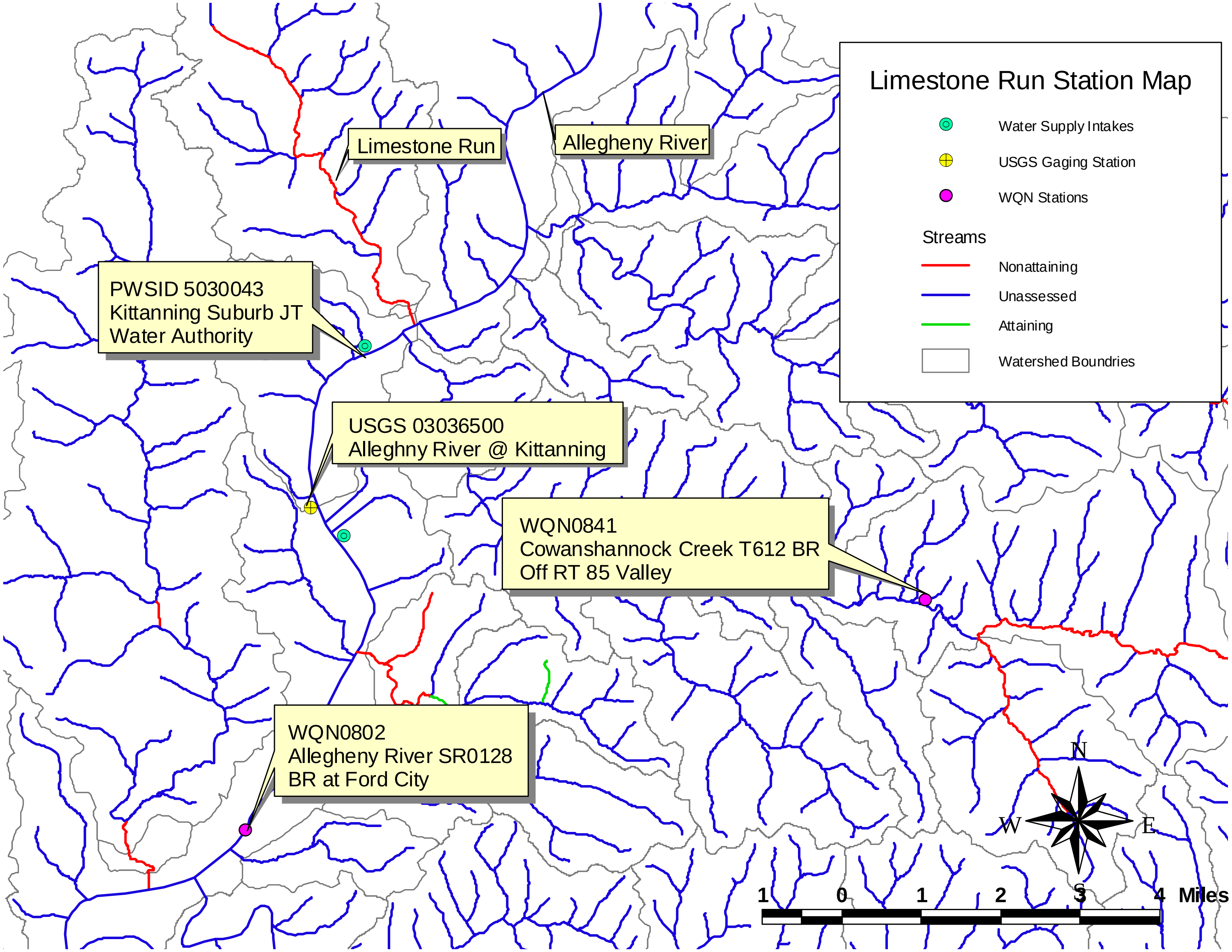

Limestone Run Station Map
Water Supply Intakes
USGS Gaging Station
WQN Stations
Streams
Nonattaining
Unassessed
Attaining
Watershed Boundries
Limestone Run
Allegheny River
PWSID 5030043
Kittanning Suburb JT
Water Authority
USGS 03036500
Alleghny River @ Kittanning
WQN0841
Cowanshannock Creek T612 BR
Off RT 85 Valley
WQN0802
Allegheny River SR0128
BR at Ford City
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Attachment B

AMD Methodology, the pH Method, and Surface Mining and Control and Reclamation Act

AMD Methodology

Two approaches are used for the TMDL analysis of AMD-affected stream segments. Both of these approaches use the same statistical method for determining the instream allowable loading rate at the point of interest. The difference between the two is based on whether the pollution sources are defined as discharges that are permitted or have a responsible party, which are considered point sources. 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 only point-source impacts or a combination of point and 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.

TMDLs and load allocations for each pollutant were determined using Monte Carlo simulation. 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 any required percent reduction so that the water quality criteria will be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

$PR = \text{maximum}\ \{0, (1-Cc/Cd)\}$ 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

$Cd = \text{RiskLognorm}(\text{Mean, Standard Deviation})$ 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:

$LTA = \text{Mean} * (1 - PR99)$ where (2)

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

LTA = allowable LTA source concentration in mg/l

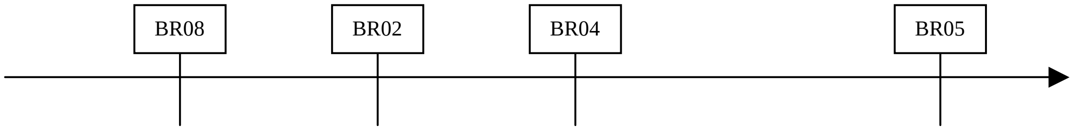
Once the required percent reduction for each pollutant source was determined, a second series of Monte Carlo simulations were performed to determine if the cumulative loads from multiple sources allow instream water quality criteria to be met at all points at least 99 percent of the time. The second series of simulations combined the flows and loads from individual sources in a stepwise fashion, so that the level of attainment could be determined immediately downstream of each source. Where available data allowed, pollutant-source flows used were the average flows. Where data were insufficient to determine a source flow frequency distribution, the average flow derived from linear regression was used.

In general, these cumulative impact evaluations indicate that, if the percent reductions determined during the first step of the analysis are achieved, water quality criteria will be achieved at all upstream points, and no further reduction in source loadings is required.

Where a stream segment is listed on the Section 303(d) list for pH impairment, the evaluation is the same as that discussed above; the pH method is fully explained in Attachment B. An example calculation from the Swatara Creek TMDL, including detailed tabular summaries of the Monte Carlo results, is presented for the Lorberry Creek TMDL in Attachment C. Information for the TMDL analysis performed using the methodology described above is contained in the TMDLs by segment section of this report in Attachment D.

Accounting for Upstream Reductions in AMD TMDLs

In AMD TMDLs, sample points are evaluated in headwaters (most upstream) to stream mouth (most downstream) order. As the TMDL evaluation moves downstream the impact of the previous, upstream, evaluations must be considered. The following examples are from the Beaver Run AMD TMDL (2003):



In the first example BR08 is the most upstream sample point and BR02 is the next downstream sample point. The sample data, for both sample points, are evaluated using @Risk (explained above) to calculate the existing loads, allowable loads, and a percentage reduction for aluminum, iron, manganese, and acidity (when flow and parameter data are available).

Any calculated load reductions for the upstream sample point, BR08, must be accounted for in the calculated reductions at sample point BR02. To do this (see table A) the allowable load is subtracted from the existing load, for each parameter, to determine the total load reduction.

Table A	Alum.	Iron	Mang.	Acidity
BR08	(#/day)	(#/day)	(#/day)	(#/day)
existing load=	3.8	2.9	3.5	0.0
allowable load=	3.8	2.9	3.5	0.0
TOTAL LOAD REDUCTION=	**0.0**	**0.0**	**0.0**	**0.0**

In table B the Total Load Reduction BR08 is subtracted from the Existing loads at BR02 to determine the Remaining Load. The Remaining Load at BR02 has the previously calculated Allowable Loads at BR02 subtracted to determine any load reductions at sample point BR02. This results in load reductions for aluminum, iron and manganese at sample point BR02.

Table B. Necessary Reductions at Beaver Run BR02

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at BR02	13.25	38.44	21.98	6.48
Total Load Reduction BR08	0.00	0.00	0.00	0.00
Remaining Load (Existing Load at BR02 - BR08)	13.25	38.44	21.98	6.48
Allowable Loads at BR02	2.91	9.23	7.03	6.48
Percent Reduction	78.0%	76.0%	68.0%	NA
Additional Removal Required at BR02	10.33	29.21	14.95	0.00

At sample point BR05 this same procedure is also used to account for calculated reductions at sample points BR08 and BR02. As can be seen in Tables C and D this procedure results in additional load reductions for iron, manganese and acidity at sample point BR04.

At sample point BR05 (the most downstream) no additional load reductions are required, see Tables E and F.

Table C	Alum.	Iron	Mang.	Acidity
BR08 & BR02	(#/day)	(#/day)	(#/day)	(#/day)
Total Load Reduction=	**10.33**	**29.21**	**14.95**	**0.0**

Table D. Necessary Reductions at Beaver Run BR04

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at BR04	12.48	138.80	54.47	38.76
Total Load Reduction BR08 & BR02	10.33	29.21	14.95	0.00
Remaining Load (Existing Load at BBR04 - TLR Sum	2.15	109.59	39.53	38.76
Allowable Loads at BR04	8.99	19.43	19.06	38.46
Percent Reduction	NA	82.3%	51.8%	0.8%
Additional Removal Required at BR04	0.00	90.16	20.46	0.29

Table E	Alum.	Iron	Mang.	Acidity
BR08 BR02 &BR04	(#/day)	(#/day)	(#/day)	(#/day)
Total Load Reduction=	10.3	29.2	14.9	0.0

Table F. Necessary Reductions at Beaver Run BR05

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at BR05	0.0	31.9	22.9	4.1
Total Load Reduction BR08, BR02 & BR04	10.3	119.4	35.4	0.3
Remaining Load (Existing Load at BBR05 - TLR Sum	NA	NA	NA	3.8
Allowable Loads at BR05	0.0	20.4	15.1	4.1
Percent Reduction	NA	NA	NA	NA
Additional Removal Required at BR05	0.0	0.0	0.0	0.0

Although the evaluation at sample point BR05 results in no additional removal this does not mean there are no AMD problems in the stream segment BR05 to BR04. The existing and allowable loads for BR05 show that iron and manganese exceed criteria and, any abandoned mine discharges in this stream segment will be addressed.

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 USEPA'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.*

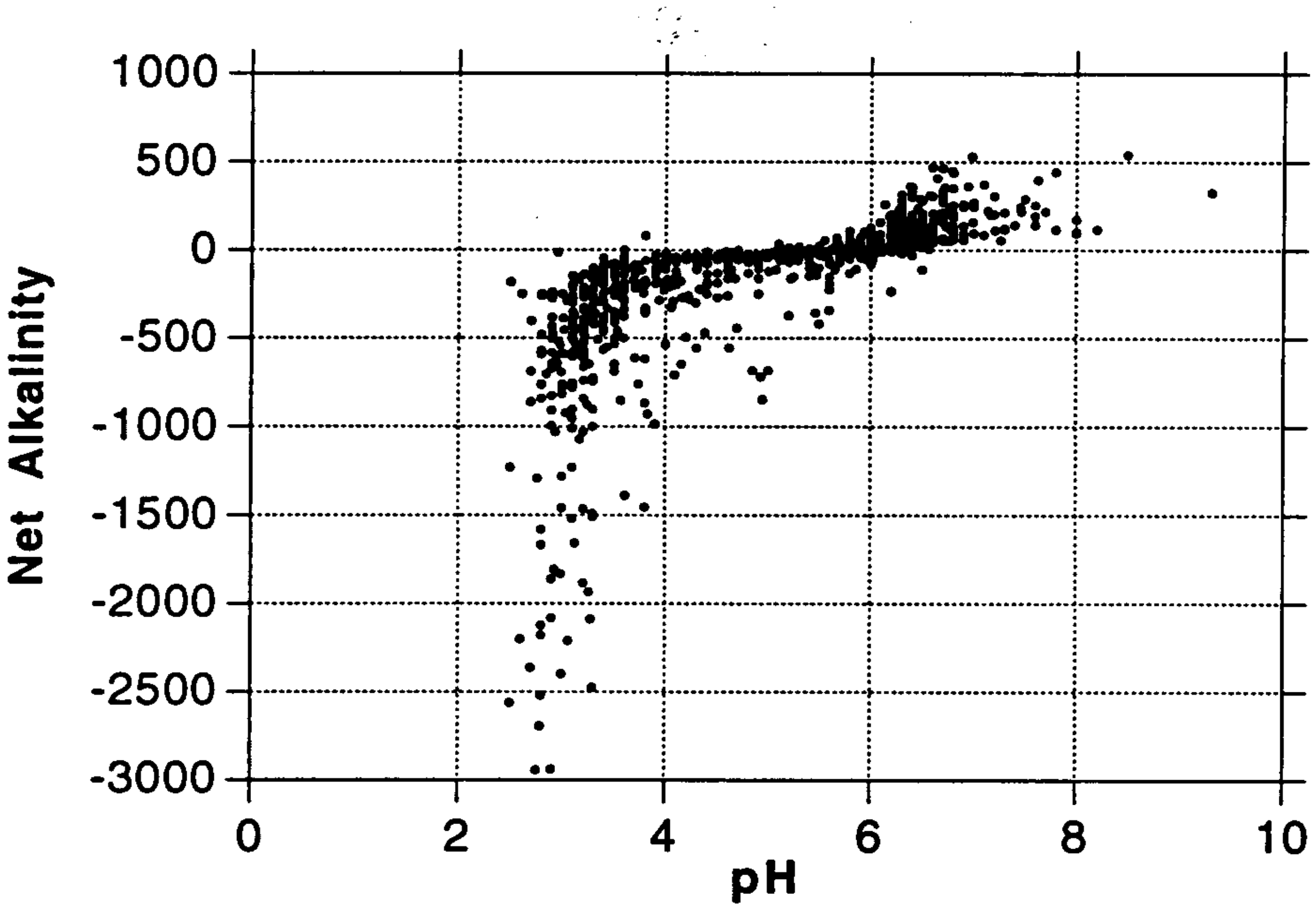


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Surface Mining Control and Reclamation Act

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to established a nationwide program to, among other things, protect the beneficial uses of land or water resources, and pubic health and safety from the adverse effects of current surface coal mining operations, as well as promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. SMCRA requires a permit for the development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by the regulatory authority in the event that the applicant forfeits. Mines that ceased operating by the effective date of SMCRA, (often called "pre-law" mines) are not subject to the requirements of SMCRA.

Title IV of the Act is designed to provide assistance for reclamation and restoration of abandoned mines, while Title V states that any surface coal mining operations shall be required to meet all applicable performance standards. Some general performance standards include:

- Restoring the affected land to a condition capable of supporting the uses which it was capable of supporting prior to any mining,

- Backfilling and compacting (to insure stability or to prevent leaching of toxic materials) in order to restore the approximate original contour of the land with all highwalls being eliminated, and topsoil replaced to allow revegetation, and

- Minimizing the disturbances to the hydrologic balance and to the quality and quantity of water in surface and ground water systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage.

For purposes of these TMDLs, point sources are identified as NPDES-permitted discharge points, and nonpoint sources include discharges from abandoned mine lands, including but not limited to, tunnel discharges, seeps, and surface runoff. Abandoned and reclaimed mine lands were treated in the allocations as nonpoint sources because there are no NPDES permits associated with these areas. In the absence of an NPDES permit, the discharges associated with these land uses were assigned load allocations.

The decision to assign load allocations to abandoned and reclaimed mine lands does not reflect any determination by EPA as to whether there are, in fact, unpermitted point source discharges within these land uses. In addition, by establishing these TMDLs with mine drainage discharges treated as load allocations, EPA is not determining that these discharges are exempt from NPDES permitting requirements.

Related Definitions

Pre-Act (Pre-Law) - Mines that ceased operating by the effective date of SMCRA and are not subject to the requirements of SMCRA.

Bond – A instrument by which a permittee assures faithful performance of the requirements of the acts, this chapter, Chapters 87-90 and the requirements of the permit and reclamation plan.

Postmining pollution discharge – A discharge of mine drainage emanating from or hydrologically connected to the permit area, which may remain after coal mining activities have been completed, and which does not comply with the applicable effluent requirements described in Chapters 87.102, 88.92, 88.187, 88.292, 89.52 or 90.102. The term includes minimal-impact postmining discharges, as defined in Section of the Surface Mining Conservation and Reclamation Act.

Forfeited Bond – Bond money collected by the regulatory authority to complete the reclamation of a mine site when a permittee defaults on his reclamation requirements.

Attachment C

Example Calculation: Lorberry Creek

Lorberry Creek was evaluated for impairment due to high metals contents in the following manner: the analysis was completed in a stepwise manner, starting at the headwaters of the stream and moving to the mouth. The Rowe Tunnel (Swat-04) was treated as the headwaters of Lorberry Creek for the purpose of this analysis.

1. A simulation of the concentration data at point Swat-04 was completed. This estimated the necessary reduction needed for each metal to meet water quality criteria 99 percent of the time as a long-term average daily concentration. Appropriate concentration reductions were made for each metal.

2. A simulation of the concentration data at point Swat-11 was completed. It was determined that no reductions in metals concentrations are needed for Stumps Run at this time. Therefore, no TMDL for metals in Stumps Run is required at this time.

3. A mass balance of loading from Swat-04 and Swat-11 was completed to determine if there was any need for additional reductions as a result of combining the loads. No additional reductions were necessary.

4. The mass balance was expanded to include the Shadle Discharge (L-1). It was estimated that best available technology (BAT) requirements for the Shadle Discharge were adequate for iron and manganese. There is no BAT requirement for aluminum. A wasteload allocation was necessary for aluminum at point L-1.

There are no other known sources below the Shadle Discharge. However, there is additional flow from overland runoff and one unnamed tributary not impacted by mining. It is reasonable to assume that the additional flow provides assimilation capacity below point L-1, and no further analysis is needed downstream.

The calculations are detailed in the following section (Tables 1-8). Table 9 shows the allocations made on Lorberry Creek.

1. A series of four equations was used to determine if a reduction was needed at point Swat-04, and, if so the magnitude of the reduction.

Table 1. Equations Used for Rowe Tunnel Analysis (SWAT 04)

	Field Description	**Equation**	**Explanation**
1	Swat-04 Initial Concentration Value (Equation 1A)	= Risklognorm (Mean, St Dev)	This simulates the existing concentration of the sampled data.
2	Swat-04 % Reduction (from the 99th percentile of percent reduction)	= (Input a percentage based on reduction target)	This is the percent reduction for the discharge.
3	Swat-04 Final Concentration Value	= Sampled Value x (1-percent reduction)	This applies the given percent reduction to the initial concentration.
4	Swat-04 Reduction Target (PR)	= Maximum (0, 1- Cd/Cc)	This computes the necessary reduction, if needed, each time a value is sampled. The final reduction target is the 99th percentile value of this computed field.

2. The reduction target (PR) was computed taking the 99th percentile value of 5,000 iterations of the equation in row four of Table 1. The targeted percent reduction is shown, in boldface type, in the following table.

Table 2. Swat-04 Estimated Target Reductions			
Name	**Swat-04 Aluminum**	**Swat-04 Iron**	**Swat-04 Manganese**
Minimum =	0	0.4836	0
Maximum =	0.8675	0.9334	0.8762
Mean =	0.2184	0.8101	0.4750
Std. Deviation =	0.2204	0.0544	0.1719
Variance =	0.0486	0.0030	0.0296
Skewness =	0.5845	-0.8768	-0.7027
Kurtosis =	2.0895	4.3513	3.1715
Errors Calculated =	0	0	0
Targeted Reduction % =	**72.2**	**90.5**	**77.0**
Target #1 (Perc%)=	99	99	99

3. This PR value was used as the percent reduction in the equation in row three of Table 1. Testing was done to see that the water quality criterion for each metal was achieved at least 99 percent of the time. This verified the estimated percent reduction necessary for each metal. Table 3 shows, in boldface type, the percent of the time criteria for each metal was achieved during 5,000 iterations of the equation in row three of Table 1.

Table 3. Swat-04 Verification of Target Reductions			
Name	**Swat-04 Aluminum**	**Swat-04 Iron**	**Swat-04 Manganese**
Minimum =	0.0444	0.2614	0.1394
Maximum =	1.5282	2.0277	1.8575
Mean =	0.2729	0.7693	0.4871
Std Deviation =	0.1358	0.2204	0.1670
Variance =	0.0185	0.0486	0.0279
Skewness =	1.6229	0.8742	1.0996
Kurtosis =	8.0010	4.3255	5.4404
Errors Calculated =	0	0	0
Target #1 (value) (WQ Criteria)=	0.75	1.5	1
Target #1 (Perc%)=	**99.15**	**99.41**	**99.02**

4. These same four equations were applied to point Swat-11. The result was that no reduction was needed for any of the metals. Tables 4 and 5 show the reduction targets computed for, and the verification of, reduction targets for Swat-11.

Table 4. Swat-11 Estimated Target Reductions			
Name	**Swat-11 Aluminum**	**Swat-11 Iron**	**Swat-11 Manganese**
Minimum =	0.0000	0.0000	0.0000
Maximum =	0.6114	0.6426	0.0000
Mean =	0.0009	0.0009	0.0000
Std Deviation =	0.0183	0.0186	0.0000
Variance =	0.0003	0.0003	0.0000
Skewness =	24.0191	23.9120	0.0000
Kurtosis =	643.4102	641.0572	0.0000
Errors Calculated =	0	0	0
Targeted Reduction % =	**0**	**0**	**0**
Target #1 (Perc%) =	99	99	99

Table 5. Swat-11 Verification of Target Reductions			
Name	**Swat-11 Aluminum**	**Swat-11 Iron**	**Swat-11 Manganese**
Minimum =	0.0013	0.0031	0.0246
Maximum =	1.9302	4.1971	0.3234
Mean =	0.0842	0.1802	0.0941
Std Deviation =	0.1104	0.2268	0.0330
Variance =	0.0122	0.0514	0.0011
Skewness =	5.0496	4.9424	1.0893
Kurtosis =	48.9148	48.8124	5.1358
Errors Calculated =	0	0	0
WQ Criteria =	**0.75**	**1.5**	**1**
% of Time Criteria Achieved =	**99.63**	**99.60**	**100**

5. Table 6 shows variables used to express mass balance computations.

Table 6. Variable Descriptions for Lorberry Creek Calculations	
Description	**Variable Shown**
Flow from Swat-04	Q_{swat04}
Swat-04 Final Concentration	C_{swat04}
Flow from Swat-11	Q_{swat11}
Swat-11 Final Concentration	C_{swat11}
Concentration below Stumps Run	C_{stumps}
Flow from L-1 (Shadle Discharge)	Q_{L1}
Final Concentration From L-1	C_{L1}
Concentration below L-1	C_{allow}

6. Swat-04 and Swat-11 were mass balanced in the following manner:

The majority of the sampling done at point Swat-11 was done in conjunction with point Swat-04 (20 matching sampling days). This allowed for the establishment of a significant correlation between the two flows (the R-squared value was 0.85). Swat-04 was used as the base flow, and a regression analysis on point Swat-11 provided an equation for use as the flow from Swat-11.

The flow from Swat-04 (Q_{swat04}) was set into an @RISK function so it could be used to simulate loading into the stream. The cumulative probability function was used for this random flow selection. The flow at Swat-04 is as follows (Equation 1):

$$Q_{swat04} = \text{RiskCumul(min,max,bin range, cumulative percent of occurrence)} \quad (1)$$

The RiskCumul function takes four arguments: minimum value, maximum value, the bin range from the histogram, and cumulative percent of occurrence.

The flow at Swat-11 was randomized using the equation developed through the regression analysis with point Swat-04 (Equation 2).

$$Q_{swat11} = Q_{swat}04 \text{ x } 0.142 + 0.088 \quad (2)$$

The mass balance equation is as follows (Equation 3):

$$C_{stumps} = ((Q_{swat04} * C_{swat04}) + (Q_{swat11} * C_{swat11}))/(Q_{swat04}+Q_{swat11}) \quad (3)$$

This equation was simulated through 5,000 iterations, and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. The results show there is no further reduction needed for any of the metals at either point. The simulation results are shown in Table 7.

Table 7. Verification of Meeting Water Quality Standards Below Stumps Run

Name	Below Stumps Run Aluminum	Below Stumps Run Iron	Below Stumps Run Manganese
Minimum =	0.0457	0.2181	0.1362
Maximum =	1.2918	1.7553	1.2751
Mean =	0.2505	0.6995	0.4404
Std Deviation =	0.1206	0.1970	0.1470
Variance =	0.0145	0.0388	0.0216
Skewness =	1.6043	0.8681	1.0371
Kurtosis =	7.7226	4.2879	4.8121
Errors Calculated =	0	0	0
WQ Criteria =	**0.75**	**1.5**	**1**
% of Time Criteria Achieved =	**99.52**	**99.80**	**99.64**

7. The mass balance was expanded to determine if any reductions would be necessary at point L-1.

The Shadle Discharge originated in 1997, and very few data are available for it. The discharge will have to be treated or eliminated. It is the current site of a USGS test remediation project. The data that were available for the discharge were collected at a point prior to a settling pond. Currently, no data for effluent from the settling pond are available.

Modeling for iron and manganese started with the BAT-required concentration value. The current effluent variability based on limited sampling was kept at its present level. There was no BAT value for aluminum, so the starting concentration for the modeling was arbitrary. The BAT values for iron and manganese are 6 mg/l and 4 mg/l, respectively. Table 8 shows the BAT-adjusted values used for point L-1.

Table 8. L-1 Adjusted BAT Concentrations

Parameter	**Measured Value**		**BAT adjusted Value**	
	Average Conc.	*Standard Deviation*	*Average Conc.*	*Standard Deviation*
Iron	538.00	19.08	6.00	0.21
Manganese	33.93	2.14	4.00	0.25

The average flow (0.048 cfs) from the discharge will be used for modeling purposes. There were not any means to establish a correlation with point Swat-04.

The same set of four equations used for point Swat-04 was used for point L-1. The equation used for evaluation of point L-1 is as follows (Equation 4):

$$C_{allow} = ((Q_{swat04}*C_{swat04})+(Q_{swat11}*C_{swat11})+(Q_{L1}*C_{L1}))/(Q_{swat04}+Q_{swat11}+Q_{L1}) \qquad (4)$$

This equation was simulated through 5,000 iterations, and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. It was estimated that an 81 percent reduction in aluminum concentration was needed for point L-1.

8. Table 9 shows the simulation results of the equation above.

Table 9. Verification of Meeting Water Quality Standards Below Point L-1			
Name	**Below L-1 Aluminum**	**Below L-1 Iron**	**Below L-1 Manganese**
Minimum =	0.0815	0.2711	0.1520
Maximum =	1.3189	2.2305	1.3689
Mean =	0.3369	0.7715	0.4888
Std Deviation =	0.1320	0.1978	0.1474
Variance =	0.0174	0.0391	0.0217
Skewness =	1.2259	0.8430	0.9635
Kurtosis =	5.8475	4.6019	4.7039
Errors Calculated =	0	0	0
WQ Criteria=	**0.75**	**1.5**	**1**
Percent of time achieved=	**99.02**	**99.68**	**99.48**

9. Table 10 presents the estimated reductions needed to meet water quality standards at all points in Lorberry Creek.

Table 10. Lorberry Creek Summary						
		Measured Sample Data		**Allowable**		**Reduction Identified**
Station	Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)	%
Swat 04						
	Al	1.01	21.45	0.27	5.79	73%
	Fe	8.55	181.45	0.77	16.33	91%
	Mn	2.12	44.95	0.49	10.34	77%
Swat 11						
	Al	0.08	0.24	0.08	0.24	0%
	Fe	0.18	0.51	0.18	0.51	00%
	Mn	0.09	0.27	0.09	0.27	00%
L-1						
	Al	34.90	9.03	6.63	1.71	81%
	Fe	6.00	1.55	6.00	1.55	0%
	Mn	4.00	1.03	4.00	1.03	0%

All values shown in this table are long-term average daily values

The TMDL for Lorberry Creek requires that a load allocation be made to the Rowe Tunnel Discharge (Swat-04) for the three metals listed, and that a wasteload allocation is made to the Shadle Discharge (L-1) for aluminum. There is no TMDL for metals required for Stumps Run (Swat-11) at this time.

Margin of Safety

For this study, the margin of safety is applied implicitly. The allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Other margins of safety used for this TMDL analysis include the following:

- None of the data sets were filtered by taking out extreme measurements. Because the 99 percent level of protection is designed to protect for the extreme event, it was pertinent not to filter the data set.

- Effluent variability plays a major role in determining the average value that will meet water quality criteria over the long term. This analysis maintained that the variability at each point would remain the same. The general assumption can be made that a treated discharge would be less variable than an untreated discharge. This implicitly builds in another margin of safety.

Attachment D

TMDLs By Segment

LIMESTONE RUN

The TMDL for Limestone Run consists of load allocations of one tributary and five sampling sites along the stream. Sample site 117 was not used in the load allocation because only two samples of data were available. Following is an explanation of the TMDL for each allocation point.

Although Limestone Run is not listed for metals as being the cause of the degradation to the stream, reductions at some points were identified. Metals will be addressed as part of this TMDL.

TMDL calculations - Limestone Run Downstream of Confluence w/ Tributary 47116, Sampling Point 111

The TMDL for sample point 111, located on Limestone Run, consists of a load allocation to all of the area above the point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point 111. The average flow, measured at the sampling point 111 (1.72 MGD), is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 111 shows pH ranging between 7.11 and 7.45; ph will not be addressed in this TMDL. The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at point 111 for manganese. 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. The following table shows the load allocations for this stream segment.

Table D1. Load Allocations at Point 111					
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	0.02	0.3	0.02	0.3	0
Fe	0.35	5.1	0.35	5.1	0
Mn	1.48	21.2	0.38	5.5	74

<u>TMDL Calculation – Mouth of Tributary 47112, Sampling Point 112</u>

The TMDL for sampling point 112, located on tributary 47112, consists of a load allocation of the area above the point shown in Attachment A. The load allocation for this tributary was computed using water-quality sample data collected at point 112. The average flow, measured at the sampling point 112 (0.77 MGD), is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 112 shows pH ranging between 7.59 and 7.74; pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

An allowable long-term average in-stream concentration was determined at point 112 for aluminum and manganese. 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. The following table shows the load allocations for this stream segment.

Table D2. Load Allocations at Point 112					
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	0.41	2.6	0.10	0.7	75
Fe	0.24	1.5	0.24	1.5	0
Mn	0.57	3.7	0.29	1.9	49

TMDL Calculation – Limestone Run Downstream of Confluence w/ Tributary 47112, Sampling Point 113

The TMDL for sampling point 113, located on Limestone Run, consists of a load allocation of the area between points 111/112 and 113 shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point 113. The average flow, measured at the sampling point 113 (2.94 MGD), is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 113 shows pH ranging between 7.14 and 7.69; pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

The existing and allowable loading for point 113 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 load reductions already specified from upstream sources. The load reductions from points 111 and 112 were subtracted from the existing load at point 113 and were compared to the allowable load for each parameter to determine if any further reductions were needed.

An allowable long-term average in-stream concentration was determined at point 113 for aluminum, iron, and manganese. 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. The following table shows the load allocations for this stream segment.

Table D3. Load Allocation at Point 113				
	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTAConc. (mg/l)	Load (lbs/day)
Al	0.20	4.9	0.11	2.7
Fe	0.82	20.1	0.49	12.0
Mn	0.96	23.5	0.33	8.2

The loading reduction for points 111 and 112 shows the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point 113. This value was then compared to the allowable load at point 113. Reductions at point 113 are necessary for any parameter that exceeded the allowable load at this point. Table D4 shows a summary of the load that affects point 113. Table D5 illustrates the necessary reductions at point 113. The results of this analysis show that reductions for aluminum and iron are necessary at this point.

Table D4. Summary of All Loads that Affect Point 113			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Sample Point 111			
load reduction=	0.0	0.0	15.7
Sample Point 112			
load reduction=	1.9	0.0	1.8

Table D5. Necessary Reductions at Sample Point 113			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Existing Loads at 113	4.9	20.1	23.5
Total Load Reduction (111 and 112)	1.9	0.0	17.5
Remaining Load (Existing Loads at 113-TLR Sum)	3.0	20.1	6.0
Allowable Loads at 113	2.7	12.0	8.2
Percent Reduction	11	40	0.0
Additional Removal Required at 113	0.3	8.1	0.0

The average flow, measured at sample point 113, is used for these computations. The TMDL for point 113 consists of load allocations for aluminum and iron to all of the area upstream of point 113 shown in Attachment A. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 113}}{\text{Remaining Load (Existing Loads at 113 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional reductions were necessary for manganese.

TMDL Calculation – Limestone Run Downstream Confluence w/ Tributary 47111, Sampling Point 114

The TMDL for sampling point 114, located on Limestone Run, consists of a load allocation of the area between sample points 113 and 114. The load allocation for this stream segment was computed using water-quality sample data collected at point 114. The average flow 3.10 MGD, measured at the sampling point, is used for these computations.

There currently is no entry for this segment on the Pa 303(d) list for impairment due to pH. Sample data at point 114 shows pH ranging between 7.51 and 7.75; pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

The existing and allowable loading for point 114 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 load reductions already specified from upstream sources. The load reduction from points 111, 112, and 113 were subtracted from the existing load at point 114 and was then compared to the allowable load for each parameter to determine if any further reductions were needed at this point.

An allowable long-term average in-stream concentration was determined at point 114 for aluminum, iron, and manganese. 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. The following table shows the load allocations for this stream segment.

Table D6. Load Allocations at Point 114				
	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTAConc. (mg/l)	Load (lbs/day)
Al	0.02	0.5	0.02	0.5
Fe	0.21	5.5	0.21	5.5
Mn	0.61	15.6	0.29	7.5

The loading reductions for points 111, 112, and 113 were summed to show the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point 114. This value was then compared to the allowable load at point 114. Reductions at point 114 are necessary for any parameter that exceeded the allowable load at this point. Table D7 shows a summary of all loads that affect point 114. Table D8 illustrates the necessary reductions at point 114. The results of this analysis show that no reductions are necessary at this point.

Table D7. Summary of All Loads that Affect Point 114			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Sample Point 111			
load reduction=	0.0	0.0	15.7
Sample Point 112			
load reduction=	1.9	0.0	1.8
Sample Point 113			
load reduction=	0.3	8.1	0.0

Table D8. Necessary Reductions at Sample Point 114			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Existing Loads at 114	0.5	5.5	15.6
Total Load Reduction (Sum of 111, 112, and 113)	2.2	8.1	17.5
Remaining Load (Existing Loads at 114-TLR Sum)	0.0	0.0	0.0
Allowable Loads at 114	0.5	5.5	7.5
Percent Reduction	0.0	0.0	0.0
Additional Removal Required at 114	0.0	0.0	0.0

The average flow, measured at sample point 114, is used for these computations. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 114}}{\text{Remaining Load (Existing Loads at 114 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary at this point.

TMDL Calculation – Limestone Run Downstream Confluence w/ Tributary 47108, Sampling Point 115

The TMDL for sampling point 115, located on Limestone Run, shown in Attachment A consists of a load allocation to the area between points 114 and 115. The load allocation for this tributary was computed using water-quality sample data collected at point 115. The average flow 3.84 MGD, measured at the sampling point, is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 115 shows pH ranging between 7.53 and 7.83; pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

The existing and allowable loading for point 115 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 load reductions already specified from upstream sources. The load reduction from points 111, 112, 113, and 114 was subtracted from the existing load at point 115 and compared to the allowable load for each parameter to determine if any further reductions were needed at this point.

An allowable long-term average in-stream concentration was determined at point 115 for aluminum, iron, and manganese. 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. The following table shows the load allocations for this stream segment.

Table D9. Load Allocations at Point 115				
	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTAConc. (mg/l)	Load (lbs/day)
Al	0.11	3.4	0.10	3.3
Fe	0.23	7.3	0.23	7.3
Mn	0.42	13.5	0.23	7.4

The loading reductions for points 111, 112, 113, and 115 shows the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point 115. This value was then compared to the allowable load at point 115. Reductions at point 115 are necessary for any parameter that exceeded the allowable load at this point. Table D10 shows a summary of all loads that affect point 115. Table D11 illustrates the necessary reductions at point 115. The results of this analysis show that no additional reductions necessary at this point.

Table D10. Summary of All Loads that Affect Point 115			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Sample Point 111			
load reduction=	0.0	0.0	15.7
Sample Point 112			
load reduction=	1.9	0.0	1.8
Sample Point 113			
load reduction=	0.3	8.1	0.0
Sample Point 114			
load reduction=	0.0	0.0	0.0

Table D11. Necessary Reductions at Sample Point 115			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Existing Loads at 115	3.4	7.3	13.5
Total Load Reduction (111, 112, 113, and 114)	2.2	8.1	17.5
Remaining Load (Existing Loads at 115-TLR Sum)	1.2	0.0	0.0
Allowable Loads at 115	3.3	7.3	7.4
Percent Reduction	0.0	0.0	0.0
Additional Removal Required at 115	0.0	0.0	0.0

The average flow, measured at sample point 115, is used for these computations. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 115}}{\text{Remaining Load (Existing Loads at 115 - TLR Sum}}\right)\right]\times 100\%$$

No additional loading reductions were necessary for aluminum, iron, or manganese at this point.

TMDL Calculation – Limestone Run near mouth, Sampling Point 118

The TMDL for sampling point 118 along Limestone Run consists of a load allocation of the area between sample points 115 and 118. The load allocation for this segment was computed using water-quality sample data collected at point 118. The average flow 4.65 MGD, measured at the sampling point, is used for these computations.

There currently is no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point 118 shows pH ranging between 7.51 and 7.85; pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

The existing and allowable loading for point 118 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 load reductions already specified from upstream sources. The load reduction from points 111, 112, 113, 114, and 115 were subtracted from the existing load at point 118 and then compared to the allowable load at 118 for each parameter to determine if any further reductions were needed at this point.

An allowable long-term average in-stream concentration was determined at point 118 for aluminum, iron, and manganese. 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. The following table shows the load allocations for this stream segment.

Table D12. Load Allocations at Point 118				
	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTAConc. (mg/l)	Load (lbs/day)
Al	0.06	2.3	0.06	2.3
Fe	0.27	10.3	0.27	10.3
Mn	0.46	17.7	0.14	5.5

The loading reductions for points 111, 112, 113, 114, and 115 were summed to show the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point 118. This value was then compared to the allowable load at point 118. Reductions at point 118 are necessary for any parameter that exceeded the allowable load at this point. Table D13 shows a summary of all loads that affect point 118. Table D14 illustrates the necessary reductions at point 118. The results of this analysis show that no additional reductions are necessary at this point.

Table D13. Summary of All Loads that Affect Point 118			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Sample Point 111			
load reduction=	0.0	0.0	15.7
Sample Point 112			
load reduction=	1.9	0.0	1.8
Sample Point 113			
load reduction=	0.3	8.1	0.0
Sample Point 114			
load reduction=	0.0	0.0	0.0
Sample Point 115			
load reduction=	0.0	0.0	0.0

Table D14. Necessary Reductions at Sample Point 118			
	Al (lbs/day)	**Fe (lbs/day)**	**Mn (lbs/day)**
Existing Loads at 118	2.3	10.3	17.7
Total Load Reduction (Sum of 111, 112, 113, 114, and 115)	2.2	8.1	17.5
Remaining Load (Existing Loads at 118-TLR Sum)	0.1	2.2	0.2
Allowable Loads at 118	2.3	10.3	5.5
Percent Reduction	0.0	0.0	0.0
Additional Removal Required at 118	0.0	0.0	0.0

The average flow, measured at sample point 118, is used for these computations. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at 118}}{\text{Remaining Load (Existing Loads at 118 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary for aluminum, iron, or manganese.

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. A correlation could not be identified because there were not enough data points to perform the analysis.

Attachment E

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

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

In the 1996 Section 303(d) list 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 Section 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 Section 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 Section 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 DEP's five-digit stream code. As a result, the unnamed tributary records are now split out as separate records on the 2000 Section 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 EPA and PADEP on the Draft 2000 Section 303(d) list, the Draft 2002 Pa Section 303(d) list was written in a manner similar to the 1998 Section 303(d) list.

Attachment F

Water Quality Data Used In TMDL Calculations

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
8C	111	000617-1430-xew	1241	7.42	8	0.02	0.39	1.8	276	5	26
35C	111	000930-1700-cb,bxp,bd	282	7.37	6	0.02	0.43	1.53	488	7	38
26G	111	010120-1200-bxp,bp	934	7.11	2.5	0.02	0.35	2.1	370	7	27
111	111	010331-1750-bxp,rxs	2322	7.45	8	0.02	0.24	0.47	315	3	19
Mean	111		**1195**	**7.34**	**6.1**	**0.02**	**0.35**	**1.48**	**362**	5.50	27.57
Stdev	111		**851**	**0.15**	**2.6**	**0.00**	**0.08**	**0.71**	**92**	1.91	8.12

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
30C	112	000617-1430-xjl	503	7.67	12.5	0.2	0.27	0.45	278	0	60
13E	112	000930-1530-cb,bxp,bd	133	7.74	2	0.02	0.09	0.10	344	8	83
69G	112	010120-1210-kap	295	7.59	3	0.02	0.09	0.73	307	4	68
112	112	010331-1650-kap	1204	7.67	11	1.4	0.51	1	297	8	67
Mean	112		**534**	**7.67**	**7.1**	**0.41**	**0.24**	**0.57**	**306**	5.00	69.72
Stdev	112		**472**	**0.06**	**5.4**	**0.67**	**0.20**	**0.39**	**28**	3.82	9.68

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
16C	113	000617-1430-xjl	2326	7.66	48.5	0.02	0.44	0.7	328	8	46
35E	113	000930-1545-cb,bxp,bd	631	7.69	15	0.02	0.41	0.32	417	10	73
66G	113	010120-1220-msb,kap	1743	7.42	36.5	0.13	1.02	1.3	367	7	46
113	113	010331-1715-kap,ash	3480	7.14	16	0.625	1.4	1.5	328	26	37
Mean	113		**2045**	**7.48**	**29.0**	**0.20**	**0.82**	**0.96**	**360**	12.75	50.50
Stdev	113		**1187**	**0.26**	**16.3**	**0.29**	**0.48**	**0.54**	**42**	8.92	15.64

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
13C	114	000617-1430-xjp	2249	7.65	8	0.02	0.26	0.45	330	4	48
39E	114	000930-1600-cb,bd,bxp	671	7.75	1	0.02	0.45	0.11	431	6	73
61G	114	010120-1240-msb,ash,kap	1412	7.51	1.5	0.02	0.07	0.86	361	5	52
114	114	010331-1623-kap	4278	7.55	9	0.02	0.07	1	304	20	43
Mean	114		**2153**	**7.62**	**4.9**	**0.02**	**0.21**	**0.61**	**356**	8.75	53.86
Stdev	114		**1557**	**0.11**	**4.2**	**0.00**	**0.18**	**0.40**	**55**	7.54	13.21

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
83B	115	000617-1625-xew	2475	7.71	9.25	0.02	0.21	0.21	274	2	46
4E	115	000930-1630-cb,bxp,bd	737	7.83	0	0.02	0.06	0.04	406	6	73
36G	115	010120-1245-bxp,bp	1960	7.54	1.5	0.02	0.05	0.58	324	9	51
115	115	010331-1620-bxp,rxs	5481	7.53	11	0.36	0.59	0.86	268	21	57
Mean	115		**2663**	**7.65**	**5.3**	**0.11**	**0.23**	**0.42**	**318**	9.50	56.58
Stdev	115		**2015**	**0.14**	**5.7**	**0.17**	**0.25**	**0.37**	**64**	8.18	11.70

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
8E	117	000930-1500-cb,bxp,bd	779	7.82	3	0.02	0.41	0.03	370	5	77
84E	117	010120-1100-bxp,bp	2397	7.47	0	0.02	0.04	0.26	311	5	54
Mean	117		**1588**	**7.65**	**1.5**	**0.02**	**0.23**	**0.15**	**341**	**5.00**	**65**
Stdev	117		**1144**	**0.25**	**2.1**	**0.00**	**0.26**	**0.16**	**42**	**0.00**	**16**

Bottle ID	Site	date-time-samplerID	Flow (gpm)	pH	TSS (mg/L)	Al (ppm)	Fe (ppm)	Mn (ppm)	SO4 (ppm)	Acidity (mg/L)	Alk (mg/L)
29C	118	000617-1530-xjl	3410	7.72	7.5	0.02	0.21	0.07	265	0	48
5E	118	000930-1420-cb,bd,bxp	715	7.85	0	0.02	0.09	0.06	358	7	75
57G	118	010120-1100-msb	2021	7.51	2	0.02	0.06	0.2	306	11	54
118	118	010331-1735-bxp,rxs	6760	7.62	10	0.18	0.7	1.5	257	7	43
Mean	118		**3227**	**7.68**	**4.9**	**0.06**	**0.27**	**0.46**	**297**	6.25	55.01
Stdev	118		**2600**	**0.14**	**4.7**	**0.08**	**0.30**	**0.70**	**46**	4.57	14.35

WQN0841	
Cowanshannock Crk	
T612 BR off Rt 85	
Date	SO4
	mg/L
8/8/1972	81
10/18/1972	111
11/16/1972	42
1/8/1973	86
3/9/1973	54
3/27/1973	37
5/8/1973	43
7/2/1973	147
5/1/1974	70
7/24/1974	240
9/17/1974	72
1/7/1975	66
4/18/1975	80
6/24/1975	65
9/3/1975	75
2/10/1976	105
5/19/1976	90
8/17/1976	29
11/8/1976	105
2/14/1977	40
5/4/1977	81
12/1/1977	35
12/28/1977	62
2/14/1978	110
5/30/1978	122
11/30/1978	102
5/22/1979	122
8/22/1979	195
9/18/1979	58
11/8/1979	105
2/6/1980	192
5/28/1980	152
8/12/1980	41
11/19/1980	240
2/18/1981	34
5/14/1981	82
8/17/1981	212
11/12/1981	96
2/3/1982	32
5/3/1982	36
11/30/1982	24

WQN0841	
Data	Sulfate Conc.
2/14/1983	62
5/18/1983	75
8/1/1983	185
11/2/1983	140
2/14/1984	41
5/9/1984	47
8/8/1984	54
10/10/1984	180
2/21/1985	93
5/8/1985	92
7/2/1985	210
8/28/1985	177
11/19/1985	40
2/19/1986	44
5/20/1986	133
8/19/1986	78
11/4/1986	113
2/19/1987	120
5/5/1987	40
8/18/1987	123
11/4/1987	175
Average	96.66129032
Stdev	56.50328397

WQN0802		
Allegheny River - SR0128 BR at Ford City		
Date	Flow	Sulfate
	cfs	mg/L
1/10/1989	18100	43
2/21/1989	20800	38
3/13/1989	9500	56
4/5/1989	59500	32
5/4/1989	16900	69
6/21/1989	102000	34
7/12/1989	8490	44
8/16/1989	3500	51
9/7/1989	4110	69
10/18/1989	4750	50
11/7/1989	8270	42
12/13/1989	15200	32
1/17/1990	18500	35
2/13/1990	36600	24

WQN0802		
3/12/1990	17600	44
4/30/1990	11100	46
5/16/1990	33300	37
6/19/1990	63200	53
7/19/1990	22800	42
8/6/1990	7310	61
9/20/1990	25500	35
10/16/1990	38100	30
11/20/1990	19700	42
12/10/1990	25800	28
1/16/1991	22900	39
2/21/1991	43100	36
3/18/1991	22400	28
4/25/1991	25100	36
5/16/1991	6430	38
6/11/1991	3640	57
7/16/1991	2900	61
8/6/1991	2240	52
9/24/1991	2910	44
10/10/1991	3900	
10/30/1991	3120	59
11/14/1991	3180	54
12/11/1991	10100	44
12/21/1991	6170	
1/2/1992	9780	32
2/4/1992	9720	39
3/2/1992	29000	30
3/17/1992	18500	
4/6/1992	22900	34
5/4/1992	25000	33
6/3/1992	5630	60
7/6/1992	4490	55
8/13/1992	13300	45
9/1/1992	18700	42
10/6/1992	18600	29
11/10/1992	24200	27
12/1/1992	28500	27
1/4/1993	53400	27
2/9/1993	9560	34
3/9/1993	23700	51
4/5/1993	55600	30
5/6/1993	17000	41
6/15/1993	5910	46
7/1/1993	3450	
7/6/1993	2880	61
8/18/1993	2540	65

WQN0802		
Date	Flow	Sulfates
9/16/1993	4320	41
10/7/1993	8020	44
10/8/1993	7470	
11/3/1993	14700	33
12/6/1993	47200	24
1/11/1994	9200	58
2/16/1994	9600	40
3/7/1994	18000	43
4/18/1994	63900	24
5/9/1994	20500	39
6/12/1994	10400	38
7/18/1994	6250	33
8/15/1994	64400	39
9/6/1994	5450	29
10/4/1994	17100	32
11/3/1994	22700	42
12/8/1994	42800	27
1/17/1995	39800	184
2/14/1995	6360	66
3/13/1995	28700	27
4/11/1995	30800	35
5/15/1995	15500	41
6/14/1995	14700	33
7/17/1995	5920	65
8/9/1995	3170	49
9/13/1995	3120	32
10/12/1995	4220	55
11/6/1995	8790	53
12/18/1995	17700	36
1/17/1996	7760	50
2/15/1996	18600	36
3/13/1996	23100	35
4/18/1996	31700	28
5/20/1996	42400	26
2/26/1996		37
7/18/1996		57
8/22/1996		63
9/11/1996		61
10/9/1996		72
11/20/1996		24
12/18/1996		20
1/23/1997		65
2/19/1997		40
3/18/1997		15
4/22/1997		48

WQN0802		
Date	Flow	Sulfates
5/22/1997		20
6/23/1997		28
7/23/1997		36
8/5/1997		46
10/6/1997		51
10/30/1997		33
11/19/1997		102
12/30/1997		27
1/14/1998		15
2/19/1998		38
3/19/1998		43
4/13/1998		25
5/7/1998		33
6/18/1998		42
7/15/1998		61
8/13/1998		38
10/19/1998		41
12/16/1998		41
Average	19419.46809	42.81355932
Stdev	17709.76648	18.99885249

Attachment G

Explanation of Sulfate Concentration Calculations

In order to show that sulfate criteria is being met at the water supply intake, it is first necessary to determine the maximum Long Term Average (LTA) background sulfate concentration of the stream at the water supply intake. The Acute Background LTA was calculated using the equation in the *Technical Support Document For Water Quality-based Toxics Control*. A Coefficient of Variation of 0.5 at a 99% Confidence Level was employed.

$LTA_{a,c} = WLA_{a,c} * e^{[0.5\sigma\wedge 2 - Z\sigma]}$

From TSD Table 5-1, $e^{[0.5\sigma\wedge 2 - z\sigma]} = 0.373$
From Title 25 Chapter 96.3(d), $WLA_{a,c} = 250$ mg/L

$LTA_{a,c} = 250$ mg/L * 0.373
$LTA_{a,c} = 93.25$ mg/L

This value is then used to determine the maximum allowable background LTA sulfate concentration of the Allegheny River just upstream of the mouth of Limestone Run. The only other stream that drains into the Allegheny River between Limestone Run and the Kittanning Suburb JT Water Authority intake is Cowanshannock Creek. The sulfate concentration and flow of Cowanshannock Creek has to be accounted for in the mass balance equation. WQN0841, located on Cowanshannock Creek, shows a fifteen-year average sulfate concentration of 96.66 mg/L. This concentration will be used as the background average sulfate concentration of Cowanshannock Creek. The flow was determined using a continuity equation.

$Q_D = Q_U + Q_L + Q_C$

Where,
Q_D = Flow at water supply intake, determined using the unit area method
Q_U = Flow above Limestone Run, determined using unit area method
Q_L = Flow of Limestone Run, measured
Q_C = Flow of Cowanshannock Creek

8292 MGD = 8224 MGD + 4.65 MGD + Q_C
Q_C = 64 MGD

The maximum upstream long-term average sulfate concentration is then calculated using a mass balance equation.

$C_L Q_L + C_C Q_C + C_U Q_U = C_D Q_D$

Where,
C_L = Sulfate Concentration Limestone Run, measured
C_C = Sulfate Concentration Cowanshannock, measured
C_D = Maximum LTA Sulfate Concentration at water supply intake
C_U = Maximum Sulfate Concentration upstream of Limestone Run

(296.50mg/L)(4.65MGD) + (96.66mg/L)(64 MGD) + 8224C_U = (93.25mg/L)(8292 MGD)

$C_U = 93.11$ mg/L

The upstream average sulfate concentration cannot exceed 93.11 mg/L in order to meet water quality criteria at the water supply intake. Data from WQN0802 on the Allegheny River approximately 8 miles downstream of Limestone Run has a ten-year average sulfate concentration of 42.81 mg/L. Conditions at the WQN are considered to be representative of the conditions just upstream of Limestone Run. This assumption is based on the minimal flow inputs between the two points, and the fact that some of the total sulfate load at the WQN station likely is from sources between the two points. It can be concluded that concentrations of sulfates do not exceed 93.1 mg/L just upstream of Limestone Run, and therefore water quality criteria for sulfate concentration is met at the water supply intake.

A map showing the location of the water supply intake, USGS Gage Station and the WQN stations is located in Appendix A. WQN data is located in Appendix F.

Attachment H

Re-mining in Pennsylvania

This attachment provides an overview and history of the re-mining requirements as related to NPDES permitting and TMDLs. Described in the following text is an overview of the regulations and incentives that pertain to the water quality aspect of the current re-mining programs in Pennsylvania.

Acid drainage from abandoned underground and surface coal mines and coal refuse piles is a large problem in the Appalachian Coal Region of the Eastern United States. Prior to the passage of the federal Surface Mining Control and Reclamation Act (SMCRA) in 1977, reclamation of mining sites was not a federal requirement and therefore, was not often done. One of SMCRA's goals was to promote the reclamation of mined areas left without adequate reclamation prior to the enactment of SMCRA and which continue, in their unreclaimed condition, to substantially degrade the quality of the environment; damage the beneficial use of land or water resources; or endanger the health or safety of the public.

In 1982, EPA promulgated final effluent limit guidelines under the Clean Water Act to limit the discharges from the coal mining industry point source category. The rule amended previously promulgated effluent limit guidelines based on "best practicable control technology" (BPT) and "new source performance standards" (NSPS), and established new guidelines based on "best available technology economically achievable" (BAT). The issue of re-mining was raised during the comment period following the 1982 proposal of the final rule. Comments addressed the fact that technology-based standards would likely serve as a deterrent to re-mining activities, since the operator would have to assume responsibility for treating effluent from previous operations that already may be significantly contaminated. This was not addressed in the final rule, and EPA stated that generally, the effluent limitations guidelines are applicable to all point source discharges even if those discharges pre-dated the re-mining operation.

In 1987, the "Rahall Amendment" to the Clean Water Act was passed, and provided incentives for re-mining abandoned mine lands that were mined prior to the 1977 passage of SMCRA. The amendment established that BAT effluent limitations for iron, manganese and pH are not required for discharges that existed prior to re-mining activities. Instead, site-specific BAT limits, determined by Best Professional Judgment (BPJ) are applicable to these pre-existing discharges, and the permit effluent limits for iron, manganese, and pH (acidity) may not exceed pre-existing baseline levels. Prior to the federal law changes in 1987, the Pennsylvania (PA) legislature amended PA SMCRA in 1984 to include re-mining incentives. Under the PA law and related regulations [25 PA Code 87, Subchapter F (bituminous coal) and Chapter 88 (anthracite coal)], a baseline pollution load is established; a pollution abatement plan is submitted incorporating best technology; and the effluent limits for the pre-existing discharges are determined by the BPJ process.

Pennsylvania has issued over 260 re-mining permits dating back to 1985 and continues to do so. For the purpose of TMDL development in watersheds where re-mining operations are occurring, the pre-existing discharges associated with the re-mining activity will not be given wasteload allocations. These loads will be accounted for in the TMDL as part of the overall load allocation. This is consistent with the Clean Water Act and PA regulations, since the current operator is not responsible for cleanup and remediation of these pre-existing discharges.

Literature Cited: U.S. EPA. 2000. Draft Coal Re-mining – Best Management Practices Guidance Manual. Report No. EPA-821-R-00-007. U.S. EPA, Washington, D.C.

Attachment I

Comment and Response

The following comments were submitted by the United States Environmental Protection Agency, Region 3 on January 14, 2003 in regards to the proposed TMDL for Limestone Run.

1. Please verify that the only discharges from the remining sites are pre-existing. Remining permit applications require monitoring, please provide that data and/or the permit requirements for the pre-existing discharges. There should be some assurance that the pre-existing loads are not larger than the TMDL loads for the segment.

   See "Segments addressed in this TMDL" section.

2. The *Watershed History* section includes the sentence, "An abandoned surface mine in the watershed above shows slight effects of AMD pollution." Since the meaning of the sentence is unclear, please clarify.

   Statement incorrect, statement removed.

3. Table 3 and Table D1 show a zero acidity concentration and loads when, in fact, they are not. Please either put the correct numbers in the tables or remove the acidity and alkalinity lines from table 3 and the tables in Attachment D.

   Values were removed.

4. The fact that remining has been permitted in the watershed indicates that more water quality data exists. Please provide EPA with the data even if it is not used in the report.

   Any additional water quality data may be obtained from the PADEP Greensburg District Mining Office.

5. Please describe the location of Sampling Point 112. Tributaries 47112 and 47114 join Limestone Run where the mainstem makes a right angle turn. Verify that Sample Point 112 is upstream of the junction on Tributary 47112 and Sample Point 113 is downstream of the junction on Limestone Run, and Sampling Points 114 and 115 are downstream of their respective tributaries.

   Text added to Attachment D to clarify locations of the Sample Points.