FINAL

BEAVER RUN WATERSHED TMDL

Jefferson County

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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 middle portion of the Redbank Creek Watershed in Jefferson County (Attachment A). It was 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. High levels of metals caused these impairments. 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 pH.

Table 1. 303(d) Sub-List

State Water Plan (SWP) Subbasin: 17-C Redbank Creek Watershed								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	3.0	5318	48447	Beaver Run	HQ-CWF/ CWF	305(b) Report	RE	Metals
1996	3.0	5318	48447	Beaver Run	HQ-CWF/ CWF	305(b) Report	RE	Other Inorganics
1998	6.27	5318	48447	Beaver Run	HQ-CWF/ CWF	SWMP	AMD	Metals
2000	6.36	5318	48447	Beaver Run	HQ-CWF/ CWF	SWMP	AMD	Metals
2002	7.3	20010516-1000-JJM	48447	Beaver Run	HQ-CWF/ CWF	SWMP	AMD	Metals

HQ = High Quality
CWF = Cold Water Fishes
RE = Resource Extraction
SWMP = Surface Water Monitoring Program
AMD = Abandoned Mine Drainage
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.
The 2002 Section 303(d) list is in draft form and has not, as yet, been finalized.

[1] Pennsylvania's 1996 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.*

Beaver Run has the designation of a high quality cold-water fishery (HQ-CWF) from the source to the PA 36 Bridge and a cold-water fishery (CWF) from PA 36 bridge to the mouth. The high quality segment supports native trout as documented in a PA Fish and Boat Commission survey conducted in September 1997. The water quality found at sample point BR08 also supports the high quality designation. Impairment of Beaver Run begins downstream of sample point BR08 and is documented by sample points BR02 and BR04.

Directions to the Beaver Run Watershed

Access to Beaver Run is from Exit #13 (Brookville) of Interstate 80 to PA route 36 south. Take PA route 36 south 8.2 miles turn right onto SR 3005 at Miller Welding, then a quick right onto SR 3007. Go 0.9 mile to a substation on the left, behind the substation, impairment begins where a deep mine discharge, sample point BRD08, meets Beaver Run. 0.5 mile past the substation SR 3007 crosses Beaver Run at Conifer. This crossing is the location of sample point BR02, the first sample point used for this TMDL. Continue on SR 3007 to the village of Ohl and make a right onto SR 3003. Go 0.4 mile and at this stream crossing is sample point BR04. This sample point is also used for this TMDL. The acid mine drainage responsible for the impairment enters Beaver Run between sample points BR08 and BR04.

To get to the mouth of Beaver Run stay on SR 3007 which will take you to the village of Heathville. The mouth is a short walk from the SR 3007 stream crossing. This is the location of sample point BR05. This sample point was not included in the TMDL because there are no additional inputs of acid mine drainage between BR04 and BR05.

Segments addressed in this TMDL

There are no active mining operations in the watershed. All of the discharges in the watershed are from abandoned mines on the Brookville coal seam and will be treated as non-point sources. 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 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.

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 water body and the scientific criteria needed to support that use. Uses can include designations for drinking water supply, contact recreation (swimming), and aquatic life support. Minimum goals set by the Clean Water Act require that all waters be “fishable” and “swimmable.”

Additionally, the federal Clean Water Act and the U.S. Environmental Protection Agency’s (USEPA) implementing regulations (40 CFR 130) require:

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

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

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

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

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

Despite these requirements, states, territories, authorized tribes, and USEPA have not developed many TMDLs since 1972. Beginning in 1986, organizations in many states filed lawsuits against the USEPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While USEPA has entered into consent agreements with the plaintiffs in several states, many lawsuits still are pending across the country.

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

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) 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.

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.

This document will present the information used to develop the Beaver Run Watershed TMDL.

Watershed History

The Beaver Run Stream Code 48447 in Basin 17-C of the State Waterplan (Attachment A) has a drainage area of 10 sq. miles. It is 6.36 miles in length and flows through the north central most area of the main bituminous coal region in Jefferson County PA. It enters Redbank Creek two miles south of the village of Summerville. It is located on the Summerville and Coolspring 7 ½ minute series topographic maps. The impairment associated with elevated metals is the result of acid drainage from abandoned coalmines and the natural condition of ground water associated with an absence or paucity of alkaline producing material in the flow path of the water.

Coal mining was first conducted in the late 1800's with small country bank mines providing coal for domestic uses. By 1910 the Conifer area was producing large amounts of deep mined coal for industrial purposes shipped by rail from a spur that ran to the mine mouth at Conifer. This large Brookville deep mine complex was active until the early 1940s when strip mining became more prevalent. The deep mines, long since abandoned, are primarily responsible for the impairment of Beaver Run.

Strip mining has taken place on the Brookville and Lower Kittanning coal seams within the impaired segment of Beaver Run with no apparent water quality problems. The McKay Coal Co. received an award from OSM for reclamation of their mine site near Ohl. MSM Coal Co. has strip mined the Freeport coal seams in the headwaters of Beaver Run on the high quality segment, with no water quality problems.

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 acceptable 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 a minimum 99 percent level of protection is required. All metals criteria evaluated in this TMDL are specified as total recoverable. Pennsylvania does have dissolved criteria for iron; however, the data used for this analysis report iron as total recoverable. Table 2 shows the water quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria

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

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

Other Inorganics

The cause of inorganic impairment as listed on the 1996 303(d) list is sulfates. Due to Title 25 Chapter 96.3(d) a TMDL to address sulfates is not necessary.[2] The nearest potable water withdrawal to Beaver Run occurs approximately 10 miles downstream of the mouth at Hawthorn Area Water Authority(#6160026). Sulfate data from WQN0820, located on Redbank Creek near the T468 bridge a St. Charles PA approximately 20 miles downstream of the mouth of Beaver Run, shows that sulfate criteria of 250 mg/L is not exceeded. The average sulfate concentration at WQN0820 (Table 5 Attachment F) is 108.45 mg/L. This average is calculated from five years of WQN data collected at the station. 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 Station 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

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

[2] Based on the supposition that the EQB will approve the addition of sulfates to §96.3(d).

Table 3. Summary Table–Beaver Run Watershed

Station	Parameter	Measured Sample Data		Allowable		Reduction Identified
		Conc. (mg/l)	Load (lb/day)	LTA Conc. (mg/l)	Load (lb/day)	Percent
BR08						
	Al	0.28	3.8	0.28	3.8	0%
	Fe	0.21	2.9	0.21	2.9	0%
	Mn	0.26	3.5	0.26	3.5	0%
	Acidity	0.00	0.0	0.00	0.0	0%
	Alkalinity	86.67	1190.2			
BR02						
	Al	0.84	13.2	0.18	2.9	78%
	Fe	2.43	38.4	0.58	9.2	76%
	Mn	1.39	22.0	0.44	7.0	68%
	Acidity	0.41	6.5	0.41	6.5	0%
	Alkalinity	62.45	989.7			
BR04						
	Al	0.35	12.5	0.25	9.0	0%
	Fe	3.91	138.8	0.55	19.4	82%
	Mn	1.53	54.5	0.54	19.1	52%
	Acidity	1.09	38.8	1.09	38.8	0.8%
	Alkalinity	35.87	1273.9			
BR05						
	Al	0.00	0.0	0.00	0.0	0%
	Fe	0.72	31.9	0.46	20.4	0%
	Mn	0.52	22.9	0.34	15.1	0%
	Acidity	0.09	4.1	0.09	4.1	0%
	Alkalinity	37.27	1654.1			

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.

Remediation efforts began in August 1998 with the construction of a 3000 ton anoxic limestone drain and wetland complex at the most upstream discharge. This system is a work in process as complications have arisen with iron and aluminum dropping out in the drain, restricting the flow through the drain. A trust fund has been established for the Redbank Creek watershed and Growing Greener grants have been awarded for additional passive treatment systems. Implementation of this TMDL can be achieved.

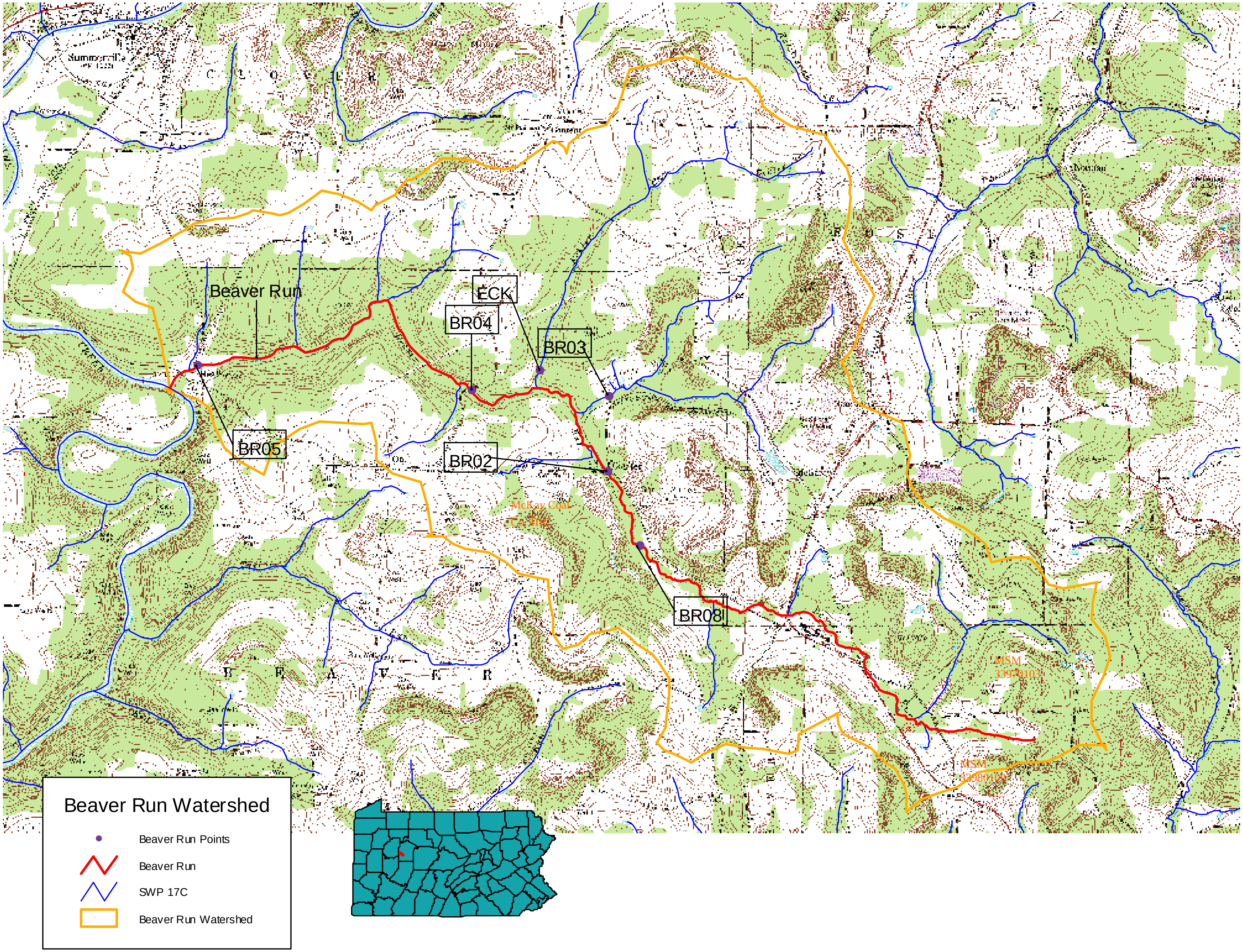
Each project will have, before and after, monitoring done to determine the remediation technique efficiency. There is a project planned at each point where a TMDL allocation has been made.

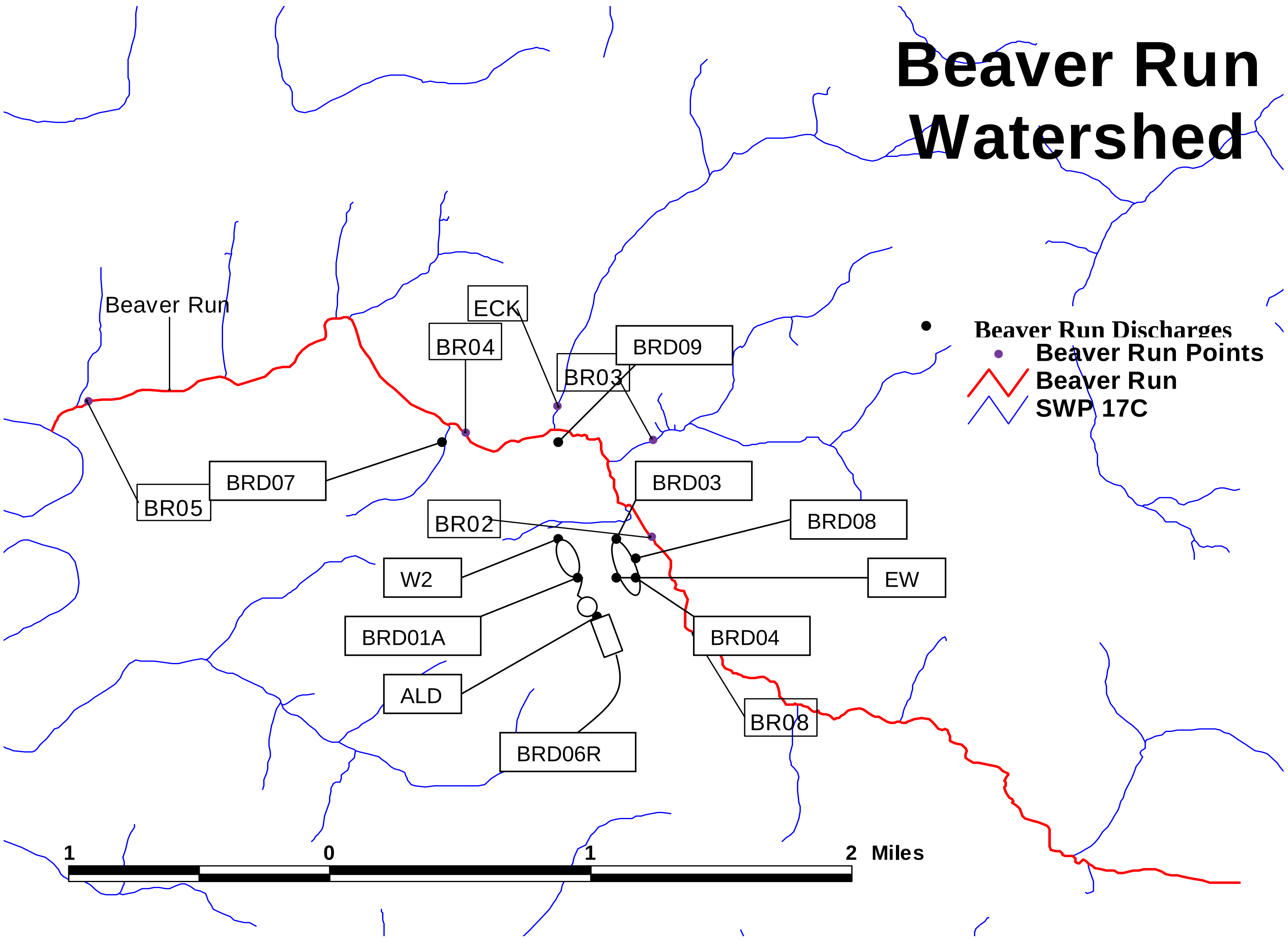
Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and the Jefferson Democrat, Brookville, PA on January 2, 2003 to foster public comment on the allowable loads calculated. A public meeting was held on January 13, 2003, at the Jefferson County Conservation District Office, to discuss the proposed TMDL.

Attachment A

Beaver Run Watershed Maps


Beaver Run
ECK
BR04
BR03
BR05
BR02
BR08
Beaver Run Watershed
Beaver Run Points
Beaver Run
SWP 17C
Beaver Run Watershed



Beaver Run Watershed
Beaver Run Discharges
Beaver Run Points
Beaver Run
SWP 17C
Beaver Run
ECK
BR04
BRD09
BR03
BRD07
BR05
BRD03
BR02
BRD08
W2
EW
BRD01A
BRD04
ALD
BR08
BRD06R
1
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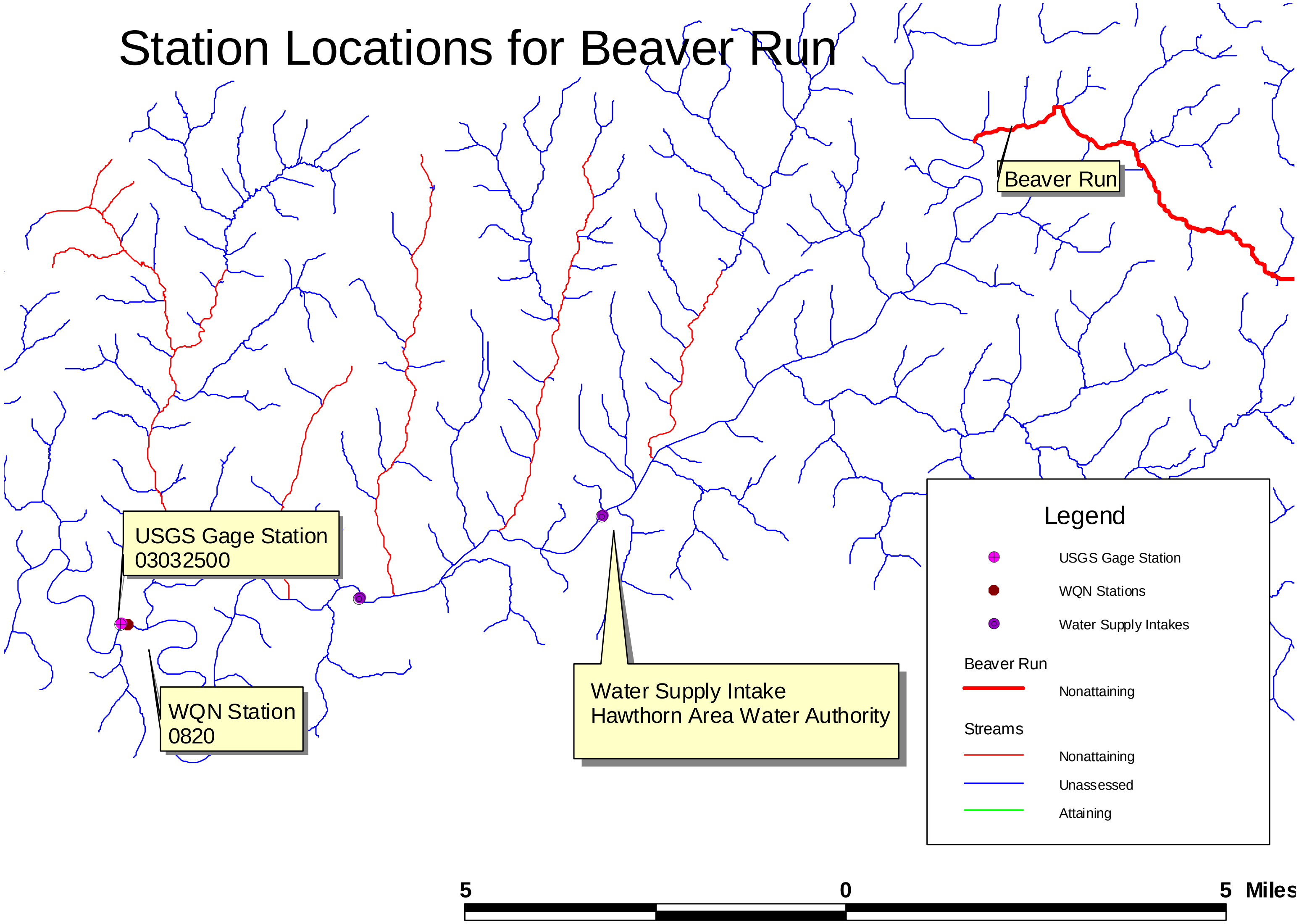
2
Miles

Station Locations for Beaver Run



Attachment B

AMD Methodology, The pH Method and Surface Mining 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 = maximum {0, (1-Cc/Cd)} where (1)

PR = required percent reduction for the current iteration
Cc = criterion in mg/l
Cd = randomly generated pollutant source concentration in mg/l based on the observed data

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

Mean = average observed concentration
Standard Deviation = standard deviation of observed data

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

LTA = Mean * (1 – PR99) where (2)

[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

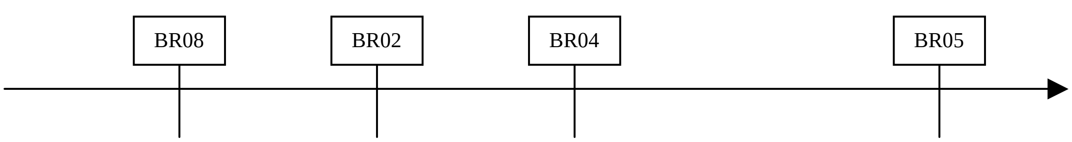
Once the required percent reduction for each pollutant source was determined, a second series of Monte Carlo simulations were performed to determine if the cumulative loads from multiple sources allow instream water quality criteria to be met at all points at least 99 percent of the time. The second series of simulations combined the flows and loads from individual sources in a step-wise 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 303(d) list for pH impairment, the evaluation is the same as that discussed above; the pH method is fully explained in Attachment C. 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 E. Information for the TMDL analysis performed using the methodology described above is contained in the TMDLs by segment section of this report in Attachment F.

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

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**

existing load, for each parameter, to determine the total load reduction.

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

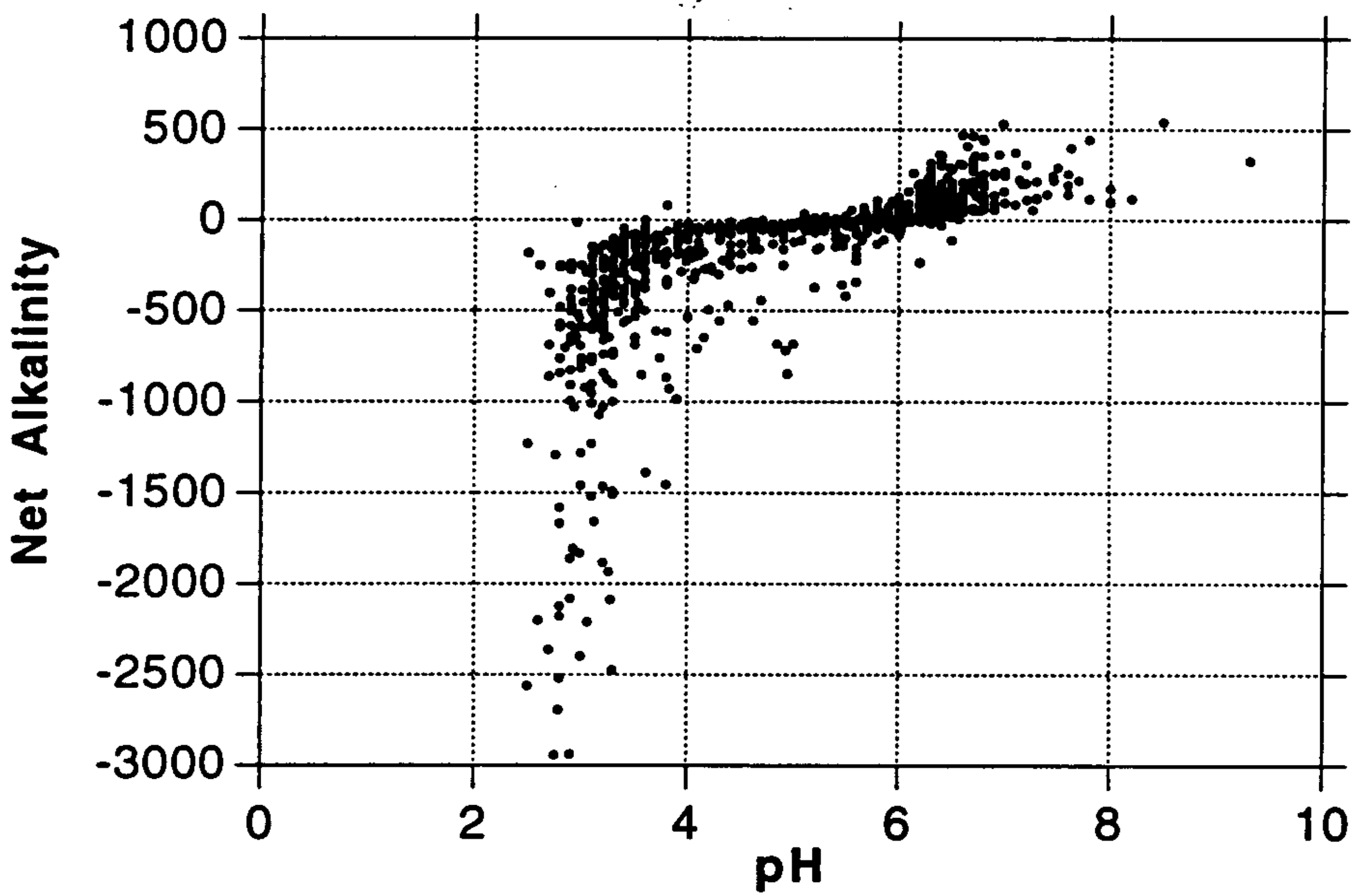


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

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 99^{th} 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 99^{th} 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).

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

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):

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

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

BEAVER RUN

There are seven acid mine discharges contributing to the impairment of Beaver Run. Five of the seven enter Beaver Run above sample point BR02. These discharges are associated with the abandoned deep mining on the Brookville coal. They are severely acidic with elevated iron, manganese and aluminum. The two discharges between sample points BR02 and BR04 are associated with a lower stratigraphic section than the deep mine discharges. One is associated with a plugged oil or gas well and the other emanates from a series of fractures in a sandstone unit right in the stream bed. They are alkaline with elevated iron.

The TMDL for Beaver Run consists of load allocations of four sampling sites along the stream. Following is an explanation of the TMDL for each allocation point.

Beaver Run is listed for both high metals and other inorganics as being the cause of the degradation to the stream. The method and rationale for addressing pH is contained in Attachment B.

TMDL calculations- Sample Point BR08

The TMDL for sample point BR08 consists of a load allocation to all 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 BR08. There were no flow measurements available at sample point BR08. Flow data was available at sample point BR02 and the unit area method was used to calculate the flow at sample point BR08 (1.65 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 BR08 shows pH ranging between 6.4 and 7.5, ph will not be addressed in this TMDL because Beaver Run upstream of BR08 is net alkaline.

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 following table shows the load allocations for this stream segment.

Table D1. Load Allocations at Point BR08					
	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA conc. (mg/l)	Load (lbs/day)	%
Al	0.28	3.8	0.28	3.8	0%
Fe	0.21	2.9	0.21	2.9	0%
Mn	0.26	3.5	0.26	3.5	0%
Acidity	0.00	0.0	0.00	0.0	0%
Alkalinity	86.67	1190.2			

The allowable loading values shown in Table 1 represent load allocations made at point BR02.

TMDL Calculations for Sample Point BR02

The TMDL for this segment of Beaver Run consists of a load allocation to the area between sample point BR08 and BR02.

There is currently no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point BR02 shows pH ranging between 5.9 and 7.1. Beaver Run at sample point BR02 is net alkaline and for this reason pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

The load allocation for this stream segment was computed using water-quality sample data collected at point BR02. The average flow measurement for sample point BR02 (1.90 mgd) was used to derive loading values for the TMDL.

The existing and allowable loading for point BR02 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 point BR08 was subtracted from the existing load at point BR08 and was compared to the allowable load at BR08 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 BR02 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. Table 1 shows the load allocations for this stream segment.

Table 1. Beaver Run BR02				
	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	Conc (mg/l)	Load (lbs/day)
Al	0.84	13.2	0.18	2.9
Fe	2.43	38.4	0.58	9.2
Mn	1.39	22.0	0.44	7.0
Acidity	0.41	6.5	0.41	6.5
Alkalinity	62.45	989.7		

The loading reductions for point BR08, shows the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point BR02. This value was then compared to the allowable load at point BR02. Reductions at point BR02 are necessary for any parameter that exceeded the allowable load at this point. Table D3 shows a summary of all loads that affect point BR02. Table D4 illustrates the necessary reductions at point BR02. The results of this analysis show that reductions for aluminum, iron, and manganese are necessary at this point.

Table D3. Summary of All Loads that Affect Point BR02				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Sample Point BR08				
load reduction=	0.0	0.0	0.0	0.0

Table D4. Necessary Reductions at Sample Point BR02				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Existing Loads at BR02	13.3	38.4	22.0	6.5
Total Load Reduction (BR08)	0.0	0.0	0.0	0.0
Remaining Load (Existing Loads at BR02-TLR Sum)	13.3	38.4	22.0	6.5
Allowable Loads at BR02	2.9	9.2	7.0	6.5
Percent Reduction	78%	76%	68%	NA
Additional Removal Required at BR02	10.3	29.2	15.0	0.0

The average flow, measured at sample point BR02, is used for these computations. The TMDL for BR02 consists of load allocations for aluminum, iron, and manganese to all of the area upstream of BR02 shown in Attachment A. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at BR02}}{\text{Remaining Load (Existing Loads at BR02 - TLR Sum}}\right)\right]\times 100\%$$

TMDL Calculation for Sample Point BR04

The TMDL for this segment of Beaver Run consists of a load allocation to the area between sample point BR04 and sample point BR02. Addressing the mining impacts above this point addresses the impairment between sample point BR04 and sample point BR02.

There is currently no entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point BR04 shows pH ranging between 5.9 and 6.5. Beaver Run at sample point BR04 is net alkaline and for this reason pH will not be addressed as part of this TMDL. The method and rationale for addressing pH is contained in Attachment B.

The load allocation for this tributary was computed using water-quality sample data collected at point BR04. There were no flow measurements available at sample point BR04. Flow data was available at sample point BR02 and the unit area method was used to calculate the flow at sample point BR04 (4.26 MGD), is used for these computations.

An allowable long-term average in-stream concentration was determined at point BR04 for iron, manganese, and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 Iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 2 shows the load allocations for this stream segment

Table D5. Beaver Run BR04				
	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	Conc (mg/l)	Load (lbs/day)
Al	0.35	12.5	0.25	9.0
Fe	3.91	138.8	0.55	19.4
Mn	1.53	54.5	0.54	19.1
Acidity	1.09	38.8	1.09	38.8
Akalinity	35.87	1273.9		

The area of the Beaver Run watershed upstream of BR04 is adversely affected by AMD and one or more allocations may be necessary at BR04. In an effort to determine if there is a need for any allocations at this point the following procedure was used.

The loading reductions for sampling point BR02 and BR08, for each parameter, were subtracted from the existing loads at points BR04. This value was then compared to the allowable load at point BR04. Reductions at point BR04 are necessary for any parameter that exceeded the allowable load at this point. Table D6 shows a summary of all loads that affect point BR04. Table D7 illustrates the necessary reductions at point BR04. The results of this analysis show that reductions for iron, manganese, and acid are necessary at this point.

Table D6. Summary of All Loads that Affect BR04				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Beaver Run (BR02 and BR08)				
load reduction=	10.3	29.2	14.9	0.0

Table D7. Necessary Reductions at Sample Point BR04				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Existing Loads at BR04	12.5	138.8	54.5	38.8
Total Load Reduction (BR02 and BR08)	10.3	29.2	14.9	0.0
Remaining Load (Existing Loads at BR04 – TLR SUM)	2.2	109.6	39.5	38.8
Allowable Loads at BR04	9.0	19.4	19.1	38.5
Percent Reduction	NA	82%	52%	0.8%
Additional Removal Required at BR04	0.0	90.2	20.5	0.3

The average flow, measured at sample point BR04, is used for these computations. The TMDL for BR04 consists of load allocations for iron, manganese, and acidity to all of the area upstream of BR04 shown in Attachment A. The percent reduction was calculated using below equation.

$$\left[1-\left(\frac{\text{Allowable Loads at BR04}}{\text{Remaining Load (Existing Loads at BR04 - TLR Sum}}\right)\right]\times 100\,\%$$

TMDL Calculation – Sample Point BR05

The TMDL for sampling point BR05 on Beaver Run consists of a load allocation to the area between the sample point BR05 and BR04, shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point BR05. The unit area flow, calculated at sampling point BR05 (5.32 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 sample point BR05 shows pH ranging between 5.0 and 7.0; pH will not be addressed as part of this TMDL because this stream segment is net alkaline. The method and rationale for addressing pH is contained in Attachment B.

The existing and allowable loading for point BR05 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 BR08, BR02, and BR04 was summed and then subtracted from the existing load at point BR05. This was compared to the allowable load at BR05 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 BR05 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. The following table shows the load allocations for this stream segment.

Table D8. Load Allocations at Point BR05				
	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTAConc. (mg/l)	Load (lbs/day)
Al	0.00	0.0	0.00	0.0
Fe	0.72	31.9	0.46	20.4
Mn	0.52	22.9	0.34	15.1
Acidity	0.09	4.1	0.09	4.1
Alkalinity	37.27	1654.1		

The loading reductions for points BR08, BR02, and BR04 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 BR05. This value was then compared to the allowable load at point BR05. Reductions at point BR05 are necessary for any parameter that exceeded the allowable load at this point. Table D9 shows a summary of all loads that affect point BR05 Table D10 illustrates the necessary reductions at point BR05. The results of this analysis show that no reductions are necessary at this point.

Table D9. Summary of All Loads that Affect Point BR05				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Sample Points BR05 and BR02				
load reduction=	10.3	29.2	14.9	0.0
Sample Point BR04				
load reduction=	0.0	90.2	20.5	0.3

Table D10 Necessary Reductions at Sample Point BR05				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Existing Loads at BR05	0.0	31.9	22.9	4.1
Total Load Reduction (Sum of BR08, BR02, and BR04)	10.3	119.4	35.4	0.3
Remaining Load (Existing Loads at BR05-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

Margin of Safety

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

- Effluent variability plays a major role in determining the average value that will meet water-quality criteria over the long-term. The value that provides this variability in our analysis is the standard deviation of the dataset. The simulation results are based on this variability and the existing stream conditions (an uncontrolled system). The general assumption can be made that a controlled system (one that is controlling and stabilizing the pollution load) would be less variable than an uncontrolled system. This implicitly builds in a margin of safety.
- A MOS is also the fact that the calculations were performed with a daily Iron average instead of the 30-day average.

Seasonal Variation

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

Critical Conditions

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

Attachment E

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

Data Table 1. Beaver Creek BR02								
DATE Collected	**FINAL FLOW (gpm)**	**PH pH units**	**ALK (mg/l)**	**HOT A (mg/l)**	**FE (mg/l)**	**MN (mg/l)**	**AL (mg/l)**	**SO4 (mg/l)**
07/09/96		6.2	24	6	5.55	2.18	2.15	280.5
08/15/96		6.3	28	3.4	3.91	1.79	2.24	273.4
09/24/96	2500	6	24	2	3.67	1.39	2.04	178.7
10/30/96		6.5	34	0	2.44	1.02	1.23	190.8
11/20/96		6.3	34	1.4	2.7	1.22	1.47	305.8
12/30/96		6.3	30	0	2.36	0.879	1.28	211.4
02/26/97		6.1	24	2	1.82	0.98	1.06	183.9
06/06/97		6.3	32	0	2.73	1.17	1.45	186.3
07/15/97	380	6.3	36	0	4.54	1.7	1.68	292.5
11/13/97		6.3	28	2.8	5.13	1.03	0.837	209.9
1/28/1998	1800	6.2	28	0	2.3	0.924	1.38	186.8
02/25/98	3250	6.1	24	0	2.65	0.78	1.41	130
03/19/98		5.9	26	0	3.24	0.903	1.88	193.1
05/13/98	2450	6.2	24	1.6	4.01	1	2.08	225.1
07/28/98		6.4	64	0	3.71	1.87	1.37	289.6
08/05/98		6.7	683	0	2.38	2.06	0.648	347.8
08/28/98		6.6	82	0	2.3	1.51	0.25	258.2
09/03/98		6.7	70	0	2.84	2.01	0.702	245
09/10/98		6.7	84	0	2.91	2.28	0.811	325
09/23/98		6.7	82	0	3.35	2.32	0.819	313
10/14/98	170	6.7	88	0	3.21	1.87	0.582	323.3
10/28/98		6.6	92	0	3.01	1.82	0.531	341.1
11/12/98		6.8	98	0	2.72	1.64	0.25	329.5
11/23/98		6.7	98	0	3.45	1.83	0.631	307.9
12/08/98		6.8	100	0	3.22	2.05	0.61	272
12/21/98		6.9	110	0	2.54	1.2	0.25	239.7
01/27/99		6.8	44	0	3.06	1.14	0.25	163.5
02/10/99		6.6	30	0	0.619	0.609	0.25	135.9
02/26/99		7.1	76	0	1.77	1.25	0.622	253.9
03/12/99		6.8	78	0	1.87	1.25	0.545	176.2
03/26/99		6.3	40	0	0.916	0.802	0.25	150.6
04/08/99	1400	6.8	66	0	0.814	1.08	0.25	340.1
04/20/99		6.7	46	0	1.29	0.842	0.25	158.3
05/11/99	1180	6.8	58	0	1.45	1.2	0.581	216.2
05/27/99		6.7	52	0	2.48	1.31	0.25	275.2
06/10/99		6.6	56	0	2.18	1.81	0.543	307.3
06/24/99		6.4	44	0	4.18	2.5	0.608	404.7
07/15/99	150	6.4	42	0	4.72	2.38	1.35	387.8
07/28/99		6.2	28	0	2.05	2.49	2.59	403.3
08/12/99		6.2	32	0	2.7	2.8	2.74	339
08/26/99		6.8	84	0	1.94	1.71	0.643	297.9
09/10/99		6.6	68	0	2.1	1.83	0.25	316.91

Data Table 1. Beaver Creek BR02								
DATE Collected	**FINAL FLOW (gpm)**	**PH pH units**	**ALK (mg/l)**	**HOT A (mg/l)**	**FE (mg/l)**	**MN (mg/l)**	**AL (mg/l)**	**SO4 (mg/l)**
11/05/99		6.4	48	0	1.3	1	0.25	299.6
11/12/99		6.6	64	0	2.47	1.46	0.25	301.3
11/18/99		6.5	68	0	3.38	1.8	0.609	190
12/10/99		6.5	48	0	1.75	0.88	0.572	112
01/05/00		6.4	30	0	1.17	0.528	0.25	2
01/28/00		6.6	72	0	4.45	1.67	0.558	330
2/25/2000		6.6	26	0	1.36	0.408	0.621	79.1
03/10/00		6.5	44	0	1.83	1.1	0.25	202.1
3/23/2000		6.6	26	0	1.73	0.721	0.516	114.9
04/06/00		6.4	11.8	8.6	3.5	0.94	1.63	135.5
04/20/00		5.6	48	0	2.11	1.19	0.55	217
05/04/00		6.4	46	0	2.42	1.21	0.734	255.3
05/11/00	600	6.7	44	0	2.11	1.32	1.25	283
5/25/2000		6.7	54	0	1.2	1.2	0.5	198
6/19/2000		6.5	34	0	1.0	0.8	1.0	162
7/25/2000		6.5	44	0	1.5	1.9	0.5	379
8/15/2000		6.6	54	0	1.5	1.7	0.5	396
9/5/2000		6.6	60	0	2.1	2.2	0.6	400
10/4/2000		6.7	76	0	1.8	1.4	0.5	318
11/7/2000		6.7	76	0	2.4	1.3	0.5	317
12/6/2000		6.7	64	0	1.6	0.8	0.5	285
1/10/2001		6.9	70	0	1.8	0.9	0.5	236
2/7/2001		6.9	52	0	0.8	0.8	0.5	153
3/21/2001		6.7	44	0	0.9	0.8	0.5	173
5/2/2001	1435	6.9	72	0	0.8	0.9	0.5	345
5/30/2001	520	7	80	0	1.2	0.9	0.5	
Avg=	1319.6	6.53	62.45	0.41	2.43	1.39	0.84	
std=				1.40	1.11	0.55	0.67	

Data Table 2. Beaver Run BR04								
DATE Collected	**FINAL FLOW (gpm)**	**PH pH units**	**ALK (mg/l)**	**HOT A (mg/l)**	**FE (mg/l)**	**MN (mg/l)**	**AL (mg/l)**	**SO4 (mg/l)**
07/09/96		6.5	24	0	5.58	1.97	0.645	258.5
08/15/96		5.9	24	0	3.93	1.83	0.855	238.1
09/24/96	4300	6.1	22	5.6	2.83	1.75	0.871	167.7
10/30/96		6.4	26	3.2	2.23	1.45	0.603	173
11/21/96		6.2	28	2.4	2.97	1.57	0.75	215.4
12/30/96		6.3	26	9.2	2.03	1.1	0.73	142.8
02/26/97		6.2	22	5.6	2.32	1.4	0.711	174.3
06/06/97		6.3	26	0.2	2.4	1.2	0.25	182.5
07/15/97		6.3	28	0	4.21	1.46	0.25	285.9
09/11/97		6.2	34	15	6.32	1.95	0.25	298.1
11/13/97		6.4	24	9	4.58	1.27	0.544	174.6
03/19/98		6.2	28	0	2.21	1.05	0.745	174.7
05/13/98		6.4	26	0	1.82	1.06	0.504	183.5
07/28/98		6.1	34	0	6.2	1.88	0.25	286.7
08/05/98		6.3	34	0	6.53	2.05	0.25	312
09/10/98		6.5	48	0	6.64	2.16	0.25	269.3
09/23/98		6.5	42	0	6.85	2.44	0.25	277
10/14/98		6.4	44	0	6.01	2.05	0.25	280.7
10/28/98		6.3	44	0	5.84	2.03	0.25	312
11/12/98		6.5	52	0	7.79	2.19	0.25	298.2
12/08/98		6.6	52	0	7.38	2.31	0.25	320
12/21/98		6.5	58	0	6.6	2.07	0.25	267.3
01/27/99		6.4	22	0	1.81	0.984	0.25	141.5
02/10/99		6.8	28	0	1.67	0.967	0.25	150.5
02/26/99		6.6	44	0	4.17	1.9	0.25	222.2
03/12/99		6.5	38	0	3.37	1.52	0.25	190.9
04/08/99		6.6	34	0	2.03	1.09	0.25	160.6
04/20/99		6.6	36	0	1.72	1.13	0.25	157
05/11/99		6.5	34	0	2.28	1.29	0.25	169
05/27/99		6.4	36	0	2.92	1.41	0.25	200.9
06/10/99		6.3	34	0	4.48	1.88	0.25	321.7
06/24/99		6.3	34	0	6.62	1.99	0.25	344.5
07/15/99		6.3	32	0	5.41	1.74	0.25	318.1
08/12/99		6.5	30	0	7.32	2.14	0.25	339
08/26/99		6.4	46	0	3.67	1.38	0.25	254.2
09/10/99		6.5	38	0	4.59	1.51	0.25	253.2
11/12/99		6.3	36	0	4.25	1.35	0.25	201.9
12/10/99		6.6	34	0	3.24	1.03	0.25	199
01/05/00		6.5	26	0	1.43	0.665	0.25	98.8
03/10/00		6.5	32	0	2.79	1.31	0.25	194.1
03/23/00		6.4	24	0	1.34	0.7	0.25	94.4
04/18/00	7400	6.3	30	0	1.65	1.23	0.25	194.2

05/04/00		6.6	112	0	2.73	1.48	0.25	232.3
05/11/00	2740		30	0	2.29	1.42	0.25	220
5/2/2001	2980	6.8	46	0	2.13	1.16	0.25	283
5/30/2001	1400	6.6	48	0	2.6	1.04	0.25	
Avg=	3764.00	6.41	35.87	1.09	3.91	1.53	0.35	
std=				3.04	1.96	0.45	0.19	

Data Table 3. Beaver Run BR08

DATE Collected	FINAL FLOW	PH pH units	ALK (mg/l)	HOT A (mg/l)	FE (mg/l)	MN (mg/l)	AL (mg/l)	SO4 (mg/l)
7/9/1996		7.5	118	0	0.15	0.337	0.25	241.3
8/15/1996		6.5	80	0	0.15	0.421	0.25	172.5
9/24/1996		6.6	66	0	0.15	0.451	0.25	110.8
10/30/1996		6.8	56	0	0.15	0.348	0.25	114.5
11/20/1996		6.7	60	0	0.15	0.46	0.25	130.9
12/30/1996		6.7	46	0	0.15	0.321	0.25	99
6/6/1997		6.7	58	0	0.15	0.242	0.25	98.6
7/15/1997		7.2	114	0	0.15	0.215	0.25	206
1/20/1998		7	60	0	0.15	0.394	0.25	139.4
1/28/1998		6.7	50	0	0.15	0.291	0.25	131.3
2/25/1998		6.4	40	0	0.15	0.369	0.25	83
3/19/1998		6.5	50	0	0.321	0.293	0.25	83.6
5/13/1998		6.7	54	0	0.15	0.258	0.25	116.5
7/28/1998		7.2	154	0	0.15	0.207	0.25	242.3
8/5/1998		7.5	156	0	0.15	0.237	0.25	251
9/23/1998		7.5	136	0	0.45	0.228	0.25	161.4
10/14/1998		7.3	156	0	0.15	0.157	0.25	207.3
10/28/1998		7.3	168	0	0.15	0.089	0.25	222.2
11/12/1998		7.4	150	0	0.15	0.132	0.25	212.2
12/8/1998		7.6	160	0	0.15	0.091	0.25	206
12/21/1998		7.6	148	0	0.15	0.07	0.25	176.7
1/27/1999		6.8	26	0	0.15	0.44	0.25	72.7
2/10/1999		6.5	34	0	0.15	0.3	0.65	133.3
2/26/1999		7.2	74	0	0.15	0.365	0.25	209.7
3/12/1999		6.8	54	0	0.15	0.365	0.25	127.6
3/26/1999		6.5	44	0	0.15	0.339	0.25	98.1
4/8/1999		6.8	50	0	0.15	0.174	0.25	167.4
4/20/1999		6.8	42	0	0.15	0.272	0.25	84
5/11/1999		7.1	68	0	0.15	0.192	0.25	110.4
5/27/1999		6.9	68	0	0.15	0.188	0.25	458.2
6/10/1999		7.2	120	0	0.15	0.215	0.25	201.8
6/24/1999		7.4	142	0	0.15	0.193	0.25	236.8
7/15/1999		7.3	142	0	0.15	0.213	0.25	263
7/28/1999		7.4	144	0	0.15	0.186	0.25	232.4

Data Table 3. Beaver Run BR08								
DATE Collected	**FINAL FLOW**	**PH pH units**	**ALK (mg/l)**	**HOT A (mg/l)**	**FE (mg/l)**	**MN (mg/l)**	**AL (mg/l)**	**SO4 (mg/l)**
8/12/1999		7.5	154	0	0.15	0.218	0.25	172
8/26/1999		7.5	140	0	0.404	0.168	0.25	217
9/10/1999		7.2	122	0	0.15	0.16	0.25	169.1
10/7/1999		7.1	112	0	0.31	0.193	0.25	153.1
11/5/1999		6.5	48	0	0.15	0.252	0.25	82
11/12/1999		7	80	0	0.15	0.25	0.25	143.9
11/18/1999		6.8	94	0	0.896	0.348	0.594	141.3
12/10/1999		6.5	60	0	0.15	0.173	0.25	134
1/500		6.8	34	0	0.315	0.16	0.25	109.3
2/25/2000		6.5	28	0	1.05	0.259	0.837	52.9
3/10/2000		6.9	60	0	0.15	0.215	0.25	139.7
3/23/2000		6.6	32	0	0.15	0.26	0.25	68.9
4/6/2000		6.4	26	0	0.437	0.374	0.25	124.4
5/4/2000		7.3	82	0	0.15	0.217	0.25	135.6
		.						
Avg=		6.97	86.67	0.00	0.21	0.26	0.28	
std=				0.00	0.18	0.10	0.11	

Data Table 4. Beaver Run BR05								
DATE Collected	**FINAL FLOW**	**PH pH units**	**ALK (mg/l)**	**HOT A (mg/l)**	**FE (mg/l)**	**MN (mg/l)**	**AL (mg/l)**	**SO4 (mg/l)**
07/09/96		7	34	0	1.01	0.831		213
08/15/96		6	26	0	0.982	0.807		145.6
09/24/96		6.2	24	0	0.694	0.958		119.3
10/30/96		6.5	24	0	0.918	0.92		132.3
11/21/96		6.3	26	0	1.32	0.982		144.2
12/30/96		6.3	24	1.8	0.892	0.686		111
02/26/97		6.2	24	0	1.46	0.997		127.7
06/06/97		6.4	28	0	0.702	0.554		102.8
06/16/97		6.6	30	0	0.582	0.664		196
07/15/97		6.4	38	0	0.3	0.308		190.7
09/11/97		6.5	46	0	0.306	0.237		248.8
11/13/97		6.4	24	2	2.04	0.828		124.8
03/19/98		6.2	24	0	1.55	0.768		146.7
05/13/98		6.5	26	0	0.722	0.651		134.3
07/28/98		6.4	48	0	0.413	0.159		252.4
08/05/98		6.7	50	0	0.374	0.121		261.8
09/10/98		6.9	56	0	0.3	0.284		241.7
09/23/98		6.8	48	0	0.462	0.421		204.7
10/14/98		6.7	56	0	0.3	0.328		231.2
10/28/98		6.9	56	0	0.3	0.267		253.1
11/12/98		6.9	62	0	0.3	0.328		282.5
12/08/98		6.9	58	0	0.3	0.087		239

Data Table 4. Beaver Run BR05								
DATE Collected	**FINAL FLOW**	**PH pH units**	**ALK (mg/l)**	**HOT A (mg/l)**	**FE (mg/l)**	**MN (mg/l)**	**AL (mg/l)**	**SO4 (mg/l)**
12/21/98		7	56	0	0.3	0.196		240.1
02/10/99		5	24	0	0.855	0.647		152.6
02/26/99		6.5	40	0	1.29	1.08		152.4
03/12/99		6.9	34	0	1.34	0.82		139.6
04/08/99		6.6	30	0	0.963	0.602		115.6
05/11/99		6.5	26	0	0.479	0.554		99.9
05/27/99		6.5	32	0	0.581	0.692		127
06/10/99		6.6	40	0	0.348	0.276		238.5
06/24/99		6.6	46	0	0.375	0.222		261.3
07/15/99		6.6	44	0	0.3	0.176		251.8
08/12/99		6.6	44	0	0.3	0.101		264.5
08/26/99		6.6	58	0	0.612	0.224		184.8
09/10/99		6.8	46	0	0.3	0.149		180.5
11/12/99		6.6	40	0	0.3	0.528		155.3
12/10/99		6.7	32	0	1.76	0.481		124
01/05/00		6.4	24	0	0.719	0.412		128.8
03/10/00		6.6	30	0	1.1	0.626		141
03/23/00		6.6	20	0	0.675	0.415		58.5
05/04/00		6.5	30	0	0.647	0.762		189
Avg=		6.53	37.27	0.09	0.72	0.52		
std=					0.46	0.29		

Data Table 5 Beaver Run BR03

Date Coll	pH pH units	Alk mg/l	Hot Acid mg/l	Fe mg/l	Mn mg/l	Al mg/l	SO4 mg/l
11/12/1998	6.5	30	0	<.3	0.7	<.5	203
9/14/2000	6.5	34	0	<.3	<.05	<.5	151

Data Table 6 Beaver Run ECK

Date Coll	pH pH units	Alk mg/l	Hot Acid mg/l	Fe mg/l	Mn mg/l	Al mg/l	SO4 mg/l
4/18/2000	6.3	18	0	<.3	<.05	<.5	64
9/14/2000	6.6	48	0	0.3	0.7	<.5	256

Beaver Run Unit Area Method Flow Calculations				
Sample Point	Area (sq. m.)	Flow (gpm)	(gpm/sq. m.)	Unit Area Flow (using BR02)
BR05	24380191.94906			3695.768
BR04	19508008.41866			2957.199
BR02	8705118.19193	1319.6	0.000152	
BR08	7543344.02920			1143.488

Data Table 5. WQN0820 Sulfate and Flow Data			
WQN0820 ~20 miles downstream of Beaver Run Redbank Crk - T468 Br at St. Charles - Porter Twp 400 feet upstream of USGS Gaging Station ~10 miles downstream of Water Suppy Intake #6160026 Hawthorn Area Water Authority			
Date	Sulfate Concentration	Mean Daily Flow	Instantaneous Flow
	mg/L	cfs	cfs
1/6/1993	57	2930	30200
2/2/1993	105	400	
3/8/1993	79	1680	1460
4/6/1993	84	1540	1560
5/11/1993	127	415	426
6/2/1993	150	362	394
7/1/1993		150	
7/6/1993	144	157	160
8/3/1993	148	352	410
9/2/1993	229	105	107
10/14/1993	129	186	187
11/1/1993	91	757	750
12/7/1993	54	2840	2960
1/12/1994	146	250	250
2/15/1994	114	230	230
3/7/1994	100	420	420
4/5/1994	67	2790	2920
5/2/1994	59	2060	2100
6/7/1994	144	535	370
7/5/1994	101	309	314
8/11/1994	185	92	92
9/8/1994	103	249	248
10/4/1994	131	641	635
12/5/1994	78	2930	2620
1/10/1995	111	220	499
2/1/1995	90	611	639
3/7/1995	14	1870	1900
4/3/1995	107	378	380
5/9/1995	118	315	307
6/13/1995	38	1840	2000
7/5/1995	110	256	257
8/8/1995	171	132	136
9/5/1995	188	49	49
10/11/1995	151	77	78
11/2/1995	155	222	234
12/4/1995	55	1110	

12/5/1995		1040	1060
Data Table 5. WQN0820 Sulfate and Flow Data			
1/16/1996	113	784	280
2/15/1996	110	599	430
3/7/1996	52	3340	3400
4/9/1996	94	796	791
5/8/1996	81	1290	1510
6/5/1996	171	292	503
7/10/1996	154	182	
8/14/1996	137	267	
9/17/1996	62	2110	
10/3/1996	76	1130	
11/7/1996	95	565	
12/4/1996	59	2830	
1/8/1997	76	1100	
2/3/1997	58	2630	
4/24/1997	92	626	
5/7/1997	71	1030	
6/10/1997	77	318	
8/12/1997	180	55.4	
9/9/1997	149	75.2	
10/7/1997	88		
11/4/1997	64		
12/8/1997	76		
1/8/1998	42		
2/4/1998	84		
3/19/1998	91		
4/22/1998	59		
5/5/1998	68		
6/3/1998	166		
7/6/1998	155		
8/4/1998	199		
10/20/1998	154		
12/27/1998	180.2		
Avg	108.45	902.14	902.15
Stdev	45.49	930.82	968.64

Attachment G
Comment and Response

Comment 1: Although the 2002 Section 303(d) list of impaired waters has not yet been finalized, it may be helpful to1) include the 2002 listing information to Table 1, and 2) a short discussion on the miles of stream listed in 2002 (7.3) and the miles covered under this TMDL. Any differences in the miles should be explained.

Response: 1) included, 2) see Attachment E

Comment 2: In the *Clean Water Act Requirements* section, please change the third bullet to read that the Section 303(d) list of impaired waters is required every *two* years under the current, applicable regulations.

Response: changed

Comment 3: The Watershed History section states that abandoned mines are primarily responsible for the impairment of Beaver Run. In the last paragraph of that section, however, there is a need for clarification regarding the strip mining operations that are mentioned (McKay Coal and MSM Coal Co.). It is not clear whether or not these operations are inactive or active. Please confirm whether or not these facilities are "bond released," included the dates, and show their location on page 12. EPA concurs that properly reclaimed mine lands are not considered a source of impairment to Beaver Run.

Response: McKay SMP 33890101 is inactive and the bond was released October 17, 1996. MSM Coal companys' two permits 33970103 and 33980109 are both inactive and the bonds are stage 2 release September 21, 2001 for 33970103 and January 13, 2003 for 33980109. See map.

Comment 4: Please consider adding the sulfate standard to Table 2 and note the proposed addition of sulfates to §96.3(d).

Response: noted

Comment 5: Not all values in Table 3 (Summary Table), on page 9, correspond to the appropriate tables in Attachment D. Specifically, the data for Aluminum for Station BR02 does not agree with Table 1 on page 31. Please verify.

Response: Corrections made to the tables.

Comment 6: The third paragraph on page 29 in Attachment D should be revised to read, "Beaver Run is listed for both high metals and other inorganics as being the cause of the degradation to the stream."

Response: revised

Comment 7: EPA would like a copy of the data for all Beaver Run sampling points shown on page 13, whether or not the data is shown in the final TMDL Report.

Response: The data for sample points BR03 and ECK have been added to Attachment F.

Comment 8: Calculations in Tables D4, D7 and D9 seem to be off slightly. The additional removal required at BR02 for iron should be 29.2, not 29.0, as shown in Table D4. The incorrect load reduction needed in manganese for BR04 is 15.0 #/day, not 14.9 #/day. The value for manganese in Tables D6 and D7 should also be revised to 15.0 to reflect the changes. The additional removal required at BR04 for iron and manganese should be 90.2 and 20.4, respectively. These proper figures were carried over to Table D9.

Response: corrections made

Comment 9: Please review Table 3, Attachment D, and the Excel® Spreadsheet for accuracy and consistency. For example, "Additional Removal Required at BR02" is shown as "15.0" on Table D4 and "14.9" in Table D7.

Response: corrections made