FINAL

BREWER RUN WATERSHED TMDL

Indiana County

For Acid Mine Drainage Affected Segments

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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 segments in the Brewer Run Watershed (Attachments 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. All impairments resulted from acid drainage from abandoned coalmines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and pH.

Table 1. 303(d) Sub-List								
State Water Plan (SWP) Subbasin: 17-D Mahoning Creek								
Year	**Miles**	**Segment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	1.7	5283	47591	Brewer Run	HQ-CWF	305(b) Report	RE	Metals
1998	1.75	5283	47591	Brewer Run	HQ-CWF	SWMP	AMD	Metals
2002	1.8	5283	47591	Brewer Run	HQ-CWF	SWMP	AMD	Metals
2004	1.8	5283	47591	Brewer Run	HQ-CWF	SWMP	AMD	Metals

Resource Extraction=RE
Cold Water Fishes = CWF
High Quality = HQ
Surface Water Monitoring Program = SWMP
Abandoned Mine Drainage = AMD
See Attachment D, *Excerpts Justifying Changes Between the 1996, 1998, 2002 and 2004 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 Brewer Run Watershed

The Brewer Run Watershed is located in Western Pennsylvania, occupying a northeastern portion of Indiana County in Canoe Township. The watershed area is found on United States Geological Survey Rochester Mills 7.5-Minute Quadrangle. The area within the watershed consists of 1.95 square miles. Land uses within the watershed include abandoned mine lands, forestlands, and rural residential properties with small communities scattered throughout the area.

[1] Pennsylvania's 1996, 1998, 2002 and 2004 Section 303(d) lists were approved by the Environmental Protection Agency (EPA). The 1996 Section 303(d) list provides the basis for measuring progress under the 1997 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

The village of Enterprise is located near the mouth of Brewer Run. Enterprise can be reached by traveling west on SR422 to Strongstown and then north on SR403 into Marion Center. In Marion Center, take East Main Street, to Richmond Road. Follow Richmond Road through Rochester Mills, to its junction with East Creek Road. Go east on East Creek Road for approximately 1.2 miles, to Painter Road, which is just outside of the village of Enterprise. Brewer Run flows underneath East Creek Road at this point, to its junction with Little Mahoning Creek, just south of Enterprise.

Hydrology and Geology

The headwaters for Brewer Run begin approximately 0.45 miles southwest of the village of Roseboro. From this point, the stream flows in a generally southern direction for approximately 2.8 miles, until it joins with Little Mahoning Creek. Through the course of its flow, it picks up one unnamed tributary from the northeast and another from the north-northwest. Brewer Run flows from an elevation of approximately 1550 feet above sea level near its headwaters to an elevation of approximately 1290 feet above sea level at its confluence with Little Mahoning Creek. Some flooded pits remain from past mining within the watershed. Although the Bureau of Abandoned Mine Reclamation has not identified any AMD dischargers, the Mine Inspector for the area has indicated that substandard post-mining discharges do exist.

The Brewer Run Watershed lies within the Appalachian Plateau Physiographic Province. The majority of the watershed is located regionally on the northwestern limb of the Jacksonville Anticline with the watershed headwaters lying approximately 1.1 miles southeast of the axis of the Elders Ridge Syncline. Strata and geologic structure within the watershed are oriented with a SW to NE trend. The prevailing direction of dip is to the northwest.

The watershed area is comprised of Pennsylvanian aged rocks, which are divided into the Pottsville and Allegheny Formations. The Glenshaw Formation of the Conemaugh Group is also represented within the watershed. Rocks from the Glenshaw Formation form the ridge tops within the watershed; however, rocks from the Allegheny Formation form the majority of the exposed geology within the watershed. The Allegheny Formation includes the Brookville, Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport and Upper Freeport coal seams. Rocks from the Pottsville Formation are only exposed near the mouth of Brewer Run before it enters Little Mahoning Creek.

Segments addressed in this TMDL

All of the discharges in the watershed are from abandoned mines and are treated as non-point sources. Each segment on the Section 303(d) list is addressed as a separate TMDL. These TMDLs are 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 C for TMDL calculations.

Clean Water Act Requirements

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

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

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

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

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

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

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

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

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

These TMDLs were developed in partial fulfillment of the 1997 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

Section 303(d) Listing Process

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

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

The assessment method requires selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the assessed stream segment can vary between sites. All the biological surveys included kick-screen sampling of benthic macroinvertebrates and habitat evaluations. 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 habitat scores and a series of narrative biological statements used to evaluate the benthic macroinvertebrate community. If the stream is determined to be impaired, the source and cause of the impairment is documented. An impaired stream must be listed on the state's Section 303(d) list with the source and cause. A TMDL must be developed for the stream segment and each pollutant. In order for the process to be more effective, adjoining stream segments with the same source and cause listing are addressed collectively, and on a watershed basis.

Basic Steps for Determining a TMDL

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

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

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

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

Watershed History

The entire watershed has been extensively mined since the turn of the century. The underground mining focused on the Upper Freeport coal seam. The surface mining operations were completed on the Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport and Upper Freeport coal seams. These past mining operations have resulted in significant scarring of the land within the watershed. Evidence of the past mining includes open pits, both dry and flooded, as well as spoil piles. The Mining Inspector for the area has indicated that substandard post-mining discharges are present within the watershed. There are currently no active mining operations within the watershed and no established NPDES discharge points.

AMD Methodology

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

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

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

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

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

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

PR = required percent reduction for the current iteration

Cc = criterion in mg/l

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

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

Mean = average observed concentration

Standard Deviation = standard deviation of observed data

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

LTA = Mean * (1 – PR99) where (2)

LTA = allowable LTA source concentration in mg/l

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

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

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

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

For pH TMDLs, acidity is compared to alkalinity as described in Attachment B. Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Statistical procedures are applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between six and eight. This method negates the need to specifically compute the pH value, which for streams affected by low pH from AMD may not a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

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

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of applicable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for a 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 most of the pollution sources in the watershed are nonpoint sources, the TMDLs' component makeup will be Load Allocations (LAs). All allocations will be specified as long-term average daily concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time as required in PA Title 25 Chapter 96.3(c). The following table shows the applicable water-quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria

Parameter	***Criterion Value (mg/l)***	***Total Recoverable/Dissolved***
Aluminum (Al)	0.75	Total Recoverable
Iron (Fe)	1.50	30 day average; Total Recoverable
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.

For High Quality waters, applicable water-quality criteria are determined using the unimpaired segment of the TMDL water or the 95th percentile of a reference WQN stream. For Brewer Run, WQN 865 McLaughlin Creek is used as the reference water. The following table shows the criteria used in the Brewer Run TMDL development. Attachment D explains how to select a reference stream for HQ TMDL development.

Table 3. Reference McLaughlin Creek Criteria

Parameter	***Criterion Value (mg/l)***
Aluminum (Al)	0.200
Iron (Fe)	0.247
Manganese (Mn)	0.029
Area	8 mi2
Alkalinity	51

TMDL Elements (WLA, LA, MOS)

TMDL = WLA + LA + MOS

A TMDL equation consists of a waste load allocation (WLA), load allocation (LA), and a margin of safety (MOS). The waste load allocation is the portion of the load assigned to point sources. The load allocation is the portion of the load assigned to non-point sources. The margin of safety is applied to account for uncertainties in the computational process. The margin of safety may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load). The TMDL allocations in this report are based on available data. Other allocation schemes could also meet the TMDL.

Allocation Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. The reduction schemes in Table 4 for each segment are based on the assumption that all upstream allocations are achieved and take into account all upstream reductions. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. An implicit MOS based on conservative assumptions in the analysis is included in the TMDL calculations.

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

Each permitted discharge in a segment is assigned a waste load allocation and the total waste load allocation for each segment is included in this table. There are currently no NPDES permitted discharges in the watershed and therefore all waste load allocations are equal to zero. The difference between the TMDL and the WLA at each point is the load allocation (LA) at the point. The LA at each point includes all loads entering the segment, including those from upstream allocation points. The percent reduction is calculated to show the amount of load that needs to be reduced within a segment in order for water quality standards to be met at the point.

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

In the instance that the allowable load is equal to the existing load (e.g. acidity point 3, Table 4), the simulation determined that water quality standards are being met instream 99% of the time and no TMDL is necessary for the parameter at that point. Although no TMDL is necessary, the loading at the point is considered at the next downstream point. In addition, when all measured values are below the method detection limit (e.g. aluminum point 4, Table 4), no TMDL is necessary. In this case the accounting for upstream loads is not carried through to the next downstream point. Rather, there is a disconnect noted and the allowable load is considered to start over because the water quality standard is satisfied.

Table 4. TMDL Component Summary for the Brewer Run Watershed

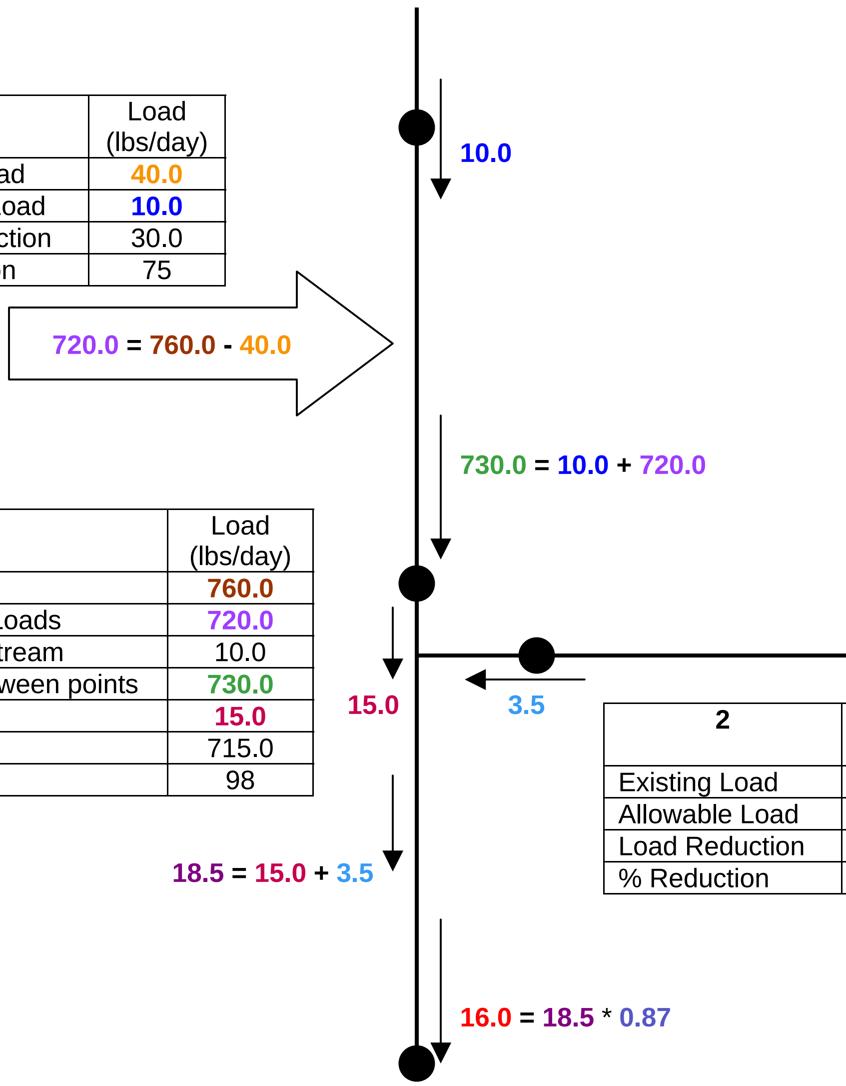
Station	Parameter	Existing Load (lbs/day)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Load Reduction (lbs/day)	Percent Reduction %
4	*Headwaters of Brewer Run*						
	Al	ND	NA	0	NA	NA	NA
	Fe	0.88	0.05	0	0.05	0.83	95%
	Mn	0.24	0.003	0	0.003	0.237	99%
	Acidity	4.30	3.24	0	3.24	1.06	25%
3	*Brewer Run downstream of Unnamed Tributary 47593*						
	Al	ND	NA	0	NA	NA	NA
	Fe	1.69	0.17	0	0.17	0.69	80%
	Mn	0.66	0.01	0	0.01	0.41	98%
	Acidity	4.32	4.32	0	NA	NA	NA
2	*Brewer Run downstream of Unnamed Tributary 47592*						
	Al	ND	NA	0	NA	NA	NA
	Fe	2.20	0.21	0	0.21	0.47	69%
	Mn	7.97	0.49	0	0.49	6.83	93%
	Acidity	ND	NA	0	NA	NA	NA
1	*Mouth of Brewer Run*						
	Al	1.72	0.23	0	0.23	1.49	87%
	Fe	5.10	0.35	0	0.35	2.76	89%
	Mn	8.0	0.08	0	0.08	0.44	85%
	Acidity	ND	NA	0	NA	NA	NA

ND, not detected.
NA meets WQS. No TMDL necessary.

* Total of loads affecting this segment is less than the allowable load calculated at this point, therefore no reduction is necessary.

Following is a generic example of how the allocations, presented in Table 4 are calculated. As demonstrated in the example, all upstream contributing loads are accounted for at each point. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. These analyses follow the example. Attachment A contains a map of the sampling point locations for reference.

4	Load (lbs/day)
Existing Load	**40.0**
Allowable Load	**10.0**
Load Reduction	30.0
% Reduction	75



3	Load (lbs/day)
Existing Load	**760.0**
Difference in Existing Loads	**720.0**
Load tracked from upstream	10.0
Total Load tracked between points	**730.0**
Allowable Load	**15.0**
Load Reduction	715.0
% Reduction required	98

2	Load (lbs/day)
Existing Load	12.0
Allowable Load	**3.5**
Load Reduction	8.5
% Reduction	71

1	Load (lbs/day)
Existing Load	675.0
Difference in Existing Loads	-97.0
Load tracked from upstream	**18.5**
% Load lost	13
% Load tracked	**87**
Total Load tracked between points	**16.0**
Allowable Load	27.0
Load Reduction	0.0
% Reduction required	0

Recommendations

Brewer Run flows to Little Mahoning Creek, which does have a watershed association; however, the Department is not aware of any projects in-place to address the extensive abandoned mine lands (AMLs) within the Brewer Run Watershed. The scope of the problems associated with these extensive AMLs, including open pits and spoil piles would need to be addressed either by the Bureau of Abandoned Mine Reclamation (BAMR), or through other programs within District Mining Operations (DMO), such as remining and Government Financed Construction Contracts (GFCCs). Any post-mining discharges of substandard quality might then be addressed through the Growing Greener Program.

Two primary programs provide maintenance and improvement of water quality in the watershed. DEP'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 DEP'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 CWA Section 319(a) Grant program and Pennsylvania's Growing Greener program has been used extensively to remedy mine drainage impacts. These many activities are expected to continue and result in water quality improvement.

The 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; administers a loan program for bonding anthracite underground mines and for mine subsidence; and administers the EPA Watershed Assessment Grant Program, the Small Operator's Assistance Program (SOAP), and the Remining Operators Assistance Program (ROAP).

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.

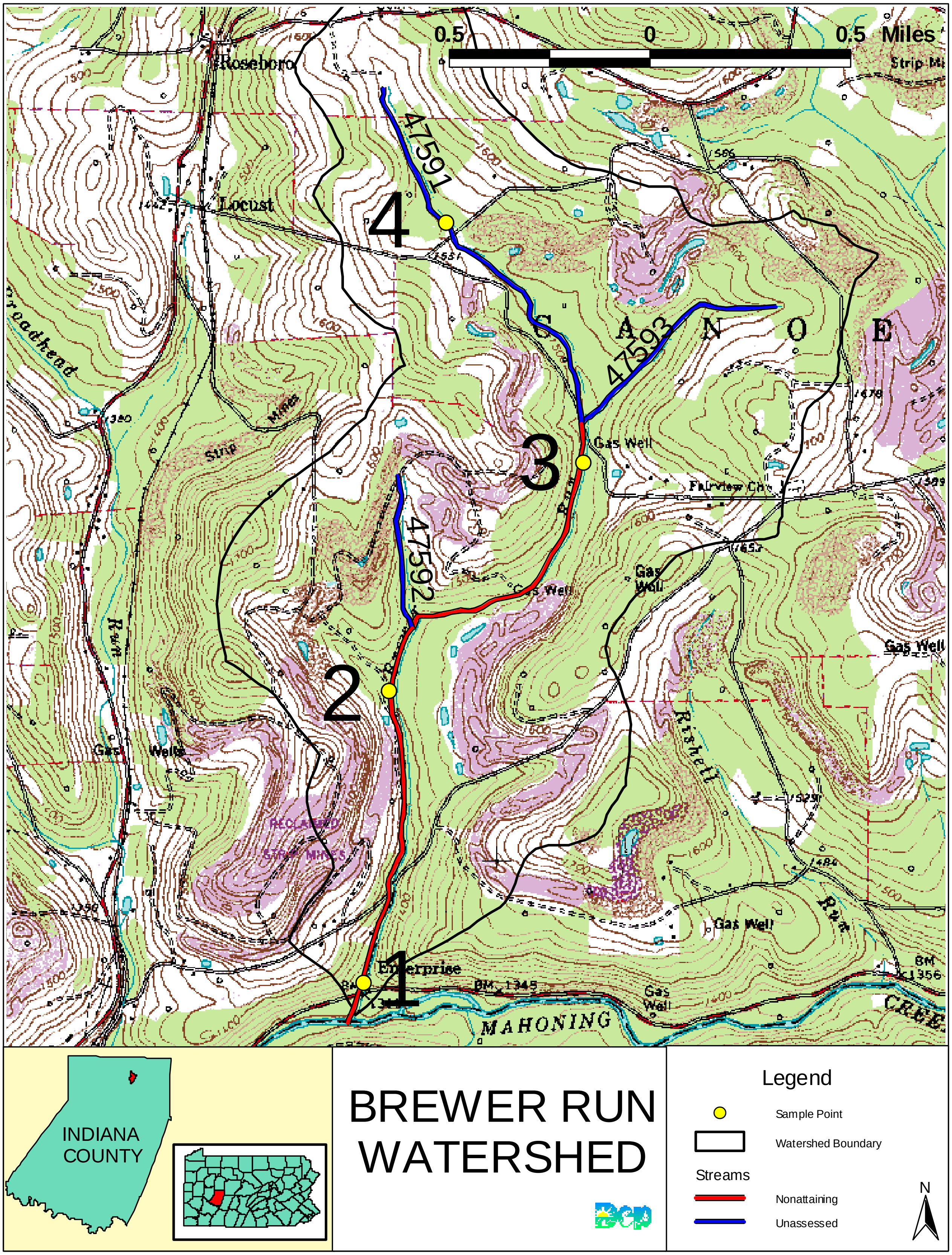
Reclaim PA is DEP's initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Abandoned mineral extraction lands in Pennsylvania constituted a significant public liability – more than 250,000 acres of abandoned surface mines, 2,400 miles of 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.

Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and the *Indiana Gazette* on 11/13/2006 to foster public comment on the allowable loads calculated. The public comment period on this TMDL was open from 11/4/2006 to 1/4/2007. A public meeting was held on 11/21/2006 at the Cambria District Mining Office, to discuss the proposed TMDL.

Attachment A

Brewer Run Watershed Maps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INDIANA COUNTY
BREWER RUN WATERSHED
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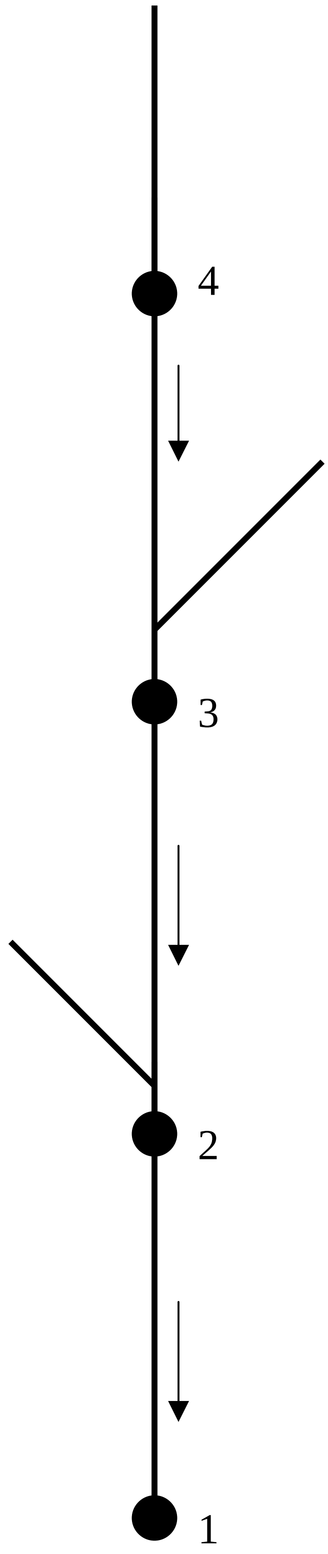
Brewer Run Sampling Station Diagram
Arrows represent direction of flow
Diagram not to scale



Attachment B

Method for Addressing Section 303(d) Listings for pH

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 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. 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. 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.

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

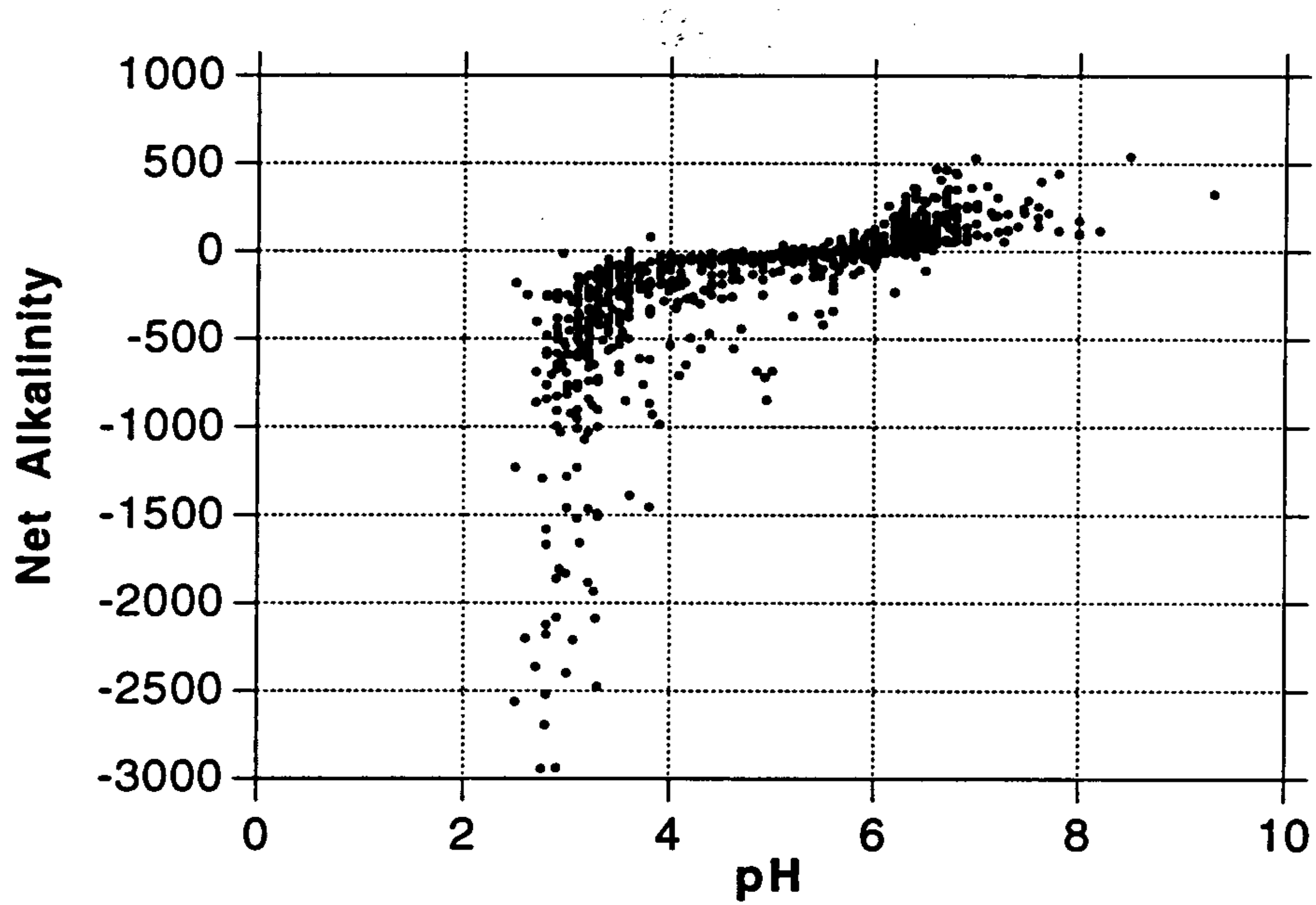


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Attachment C
TMDLs By Segment

Brewer Run

The TMDL for the Brewer Run consists of load allocations of four sampling sites along the stream. Because there are no permitted discharges in the watershed, no WLAs are assigned.

Brewer Run is listed as impaired on the PA Section 303(d) list by high metals from AMD as being the cause of the degradation to the stream. The stream is not listed for pH impairments; however, data shows that the water quality standard is not met at all points. Because the water quality standard is not met, pH is addressed as part of the TMDL for Brewer Run. The method and rationale for addressing pH is contained in Attachment B.

Currently, the Pennsylvania Code Title 25 lists the Brewer Run Watershed as HQ-CWF. In TMDL calculations, an endpoint allows for comparison between observed instream conditions and conditions that are expected to restore designated uses. For HQ-CWF streams, a WQN stream is used as a reference. The applicable water quality criteria shown in Table 3 for WQN 865 McLaughlin Creek will be used as the target endpoint.

An allowable long-term average in-stream concentration was determined at each point for iron, manganese, aluminum, 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.

TMDL Calculations - Sample Point 4, Headwaters of Brewer Run

The TMDL for sample point 4 consists of a load allocation to all of the area above the point (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point 4. The average flow of 0.10 MGD, measured at the point, is used for these computations.

This segment is not included on the PA Section 303(d) list for impairments from AMD. Sample data at point 4 shows pH ranging between 5.4 and 7.1; pH is addressed as part of this TMDL. All aluminum concentrations at point 4 are below the detectable limit, ND denotes this. Because the WQS is met, a TMDL for aluminum is not necessary at point 4.

Table C1. TMDL Calculations at Point 4				
Flow = 0.10 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	ND	NA	ND	NA
Fe	1.07	0.88	0.06	0.045
Mn	0.29	0.24	0.00	0.003
Acidity	5.23	4.30	3.94	3.24
Alkalinity	32.23	26.51		

Table C2. Allocations 4			
4	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ 4	0.88	0.24	4.30
Allowable Load @ 4	0.05	0.003	3.24
Load Reduction @ 4	0.835	0.237	1.06
% Reduction required @ 4	95%	98.8%	25%

TMDL Calculations - Sample Point 3, Brewer Run downstream of Unnamed Tributary 47593

The TMDL for sample point 3 consists of a load allocation to all of the area between points 3 and 4 (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point 3. The average flow of 0.22 MGD, measured at the point, is used for these computations.

This segment was included on the PA Section 303(d) list for impairments from AMD. Sample data at point 3 shows pH ranging between 6.3 and 7.6; pH is not addressed as part of this TMDL. All aluminum concentrations at point 3 are below the detectable limit and sample acidic values required no reductions, ND denotes this. Because the WQS is met, a TMDL for aluminum and acidity is not necessary at point 3.

Table C3. TMDL Calculations at Point 3				
Flow = 0.22 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	ND	NA	ND	NA
Fe	0.94	1.69	0.10	0.17
Mn	0.37	0.66	0.01	0.01
Acidity	2.40	4.32	2.40	4.32
Alkalinity	48.40	87.19		

The calculated upstream load reductions for all the loads that enter point 3 must be accounted for in the calculated reductions at the sample point shown in Table C4. A comparison of measured loads between points 3 and 4 shows that there is an increase in the iron and manganese loadings. The total segment load is the sum of the upstream loads and any additional load entering the segment.

Table C4. Allocations 3		
3	Fe (Lbs/day)	Mn (Lbs/day)
Existing Load @ 3	1.69	0.66
Difference in measured Loads between the loads that enter and existing 3	0.81	0.42
Additional load tracked from above samples	0.05	0.00
Total load tracked between4 and 3	0.86	0.42
Allowable Load @ 3	0.17	0.01
Load Reduction @ 3	0.69	0.41
% Reduction required at 3	80%	98%

TMDL Calculations - Sample Point 2, Brewer Run downstream of Unnamed Tributary 47592

The TMDL for sample point 2 consists of a load allocation to all of the area between points 2 and 3 (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point 2. The average flow of 0.78 MGD, measured at the point, is used for these computations.

This segment was included on the 1996 PA Section 303(d) list for metals impairments from AMD. Sample data at point 2 shows pH ranging between 6.5 and 7.6; pH is not addressed as part of this TMDL. All aluminum concentrations at point 2 are below the detectable limits and there was no acidity measured at sample point 2. ND denotes these parameters. Because the WQS is met, a TMDL for aluminum and acidity is not necessary at point 2.

Table C5. TMDL Calculations at Point 2				
Flow = 0.78 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	ND	NA	ND	NA
Fe	0.34	2.20	0.03	0.21
Mn	1.23	7.97	0.01	0.07
Acidity	ND	NA	ND	NA
Alkalinity	47.76	310.42		

The calculated upstream load reductions for all the loads that enter point 2 must be accounted for in the calculated reductions at the sample point shown in Table C6. A comparison of measured loads between points 2 and 3 shows that there is an increase in iron and manganese loading. The total segment iron and manganese loads are the sum of the upstream loads and any additional load entering the segment.

Table C6. Allocations 2		
2	Fe (Lbs/day)	Mn (Lbs/day)
Existing Load @ 2	2.20	7.97
Difference in measured Loads between the loads that enter and existing 2	0.51	7.31
Additional load tracked from above samples	0.17	0.01
Total load tracked between 3 and 2	0.68	7.32
Allowable Load @ 2	0.21	0.49
Load Reduction @ 2	0.47	6.83
% Reduction required at 2	69%	93%

TMDL Calculations - Sample Point 1, Mouth of Brewer Run

The TMDL for sample point 1 consists of a load allocation to all of the area between points 1 and 2 (Attachment A). The load allocation for this segment was computed using water-quality sample data collected at point 1. The average flow of 1.46 MGD, measured at the point, is used for these computations.

This segment was included on the 1996 PA Section 303(d) list for metals impairments from AMD. Sample data at point 1 shows pH ranging between 6.5 and 7.8; pH is not addressed as part of this TMDL.

Table C7. TMDL Calculations at Point 1				
Flow = 1.46 MGD	Measured Sample Data		Allowable	
Parameter	Conc. (mg/l)	Load (lbs/day)	LTA Conc. (mg/l)	Load (lbs/day)
Al	0.14	1.72	0.02	0.23
Fe	0.42	5.10	0.03	0.35
Mn	0.66	8.00	0.01	0.08
Acidity	ND	NA	ND	NA
Alkalinity	46.02	561.00		

The calculated upstream load reductions for all the loads that enter point 1 must be accounted for in the calculated reductions at the sample point shown in Table C8. A comparison of measured loads between points 1 and 2 shows that there is an increase in aluminum, iron and manganese loading. The total segment aluminum, iron and manganese loads are the sum of the upstream loads and any additional load entering the segment.

Table C8. Allocations 1			
1	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)
Existing Load @ 1	1.72	5.10	8.00
Difference in measured Loads between the loads that enter and existing 1	1.72	2.90	0.03
Additional load tracked from above samples	0.00	0.21	0.49
Total load tracked between 2 and 1	1.72	3.11	0.52
Allowable Load @ 1	0.23	0.35	0.08
Load Reduction @ 1	1.49	2.76	0.44
% Reduction required at 1	87%	89%	85%

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is implicit because 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:

- 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.

Seasonal Variation

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

Critical Conditions

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

Attachment D

Use of reference stream for High Quality waters

Streams placed on the 1996 303 (d) list with a designated use of High Quality (HQ) will be subject to Pennsylvania's anti degradation policy. Therefore, DEP must establish instream goals for TMDLs that restore the waterbody to existing (pre-mining) quality.

This is accomplished by sampling an unaffected stretch of stream to use as a reference. This stretch typically is the headwaters segment of the High Quality stream in question. If an unaffected stretch isn't available, a nearby-unimpaired stream will function as a surrogate reference.

The reference stream data will be selected from statewide ambient Water Quality Network (WQN) stations. To determine which WQN station represents existing water quality appropriate for use in developing TMDLs for HQ waters, alkalinity and drainage area are considered.

1. First step is to match alkalinities of TMDL stream and WQN reference stream. If alkalinities for candidate stream are not available, use pH as a surrogate. As a last resort, if neither pH nor alkalinity are available match geologies using current geological maps.
2. The second consideration is drainage area.
3. Finally, from the subset of stations with similar alkalinity and drainage area select the station nearest the TMDL stream.

Once a reference stream is selected, the 95th percentile confidence limit on the median for aluminum, iron and manganese is used as the applicable water quality criteria and run the @Risk model.

Attachment E

Excerpts Justifying Changes Between the 1996, 1998, 2002 and 2004 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 2002and 2004 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).

Attachment F
Water Quality Data Used In TMDL Calculations

Site	Date	Flow (gpm)	pH	Alk (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)
4	6/13/01	10	7.1	42.0	0.0	0.94	<0.05	<0.5
Latitude:	7/18/01	No Flow						
40-51-23	12/26/01		5.4	15.2	11.0	0.51	<0.05	<0.5
Longitude:	6/13/02	100	6.6	24.0	0.0	1.19	0.08	<0.5
78-57-39	7/17/02	1	6.9	66.0	0.0	3.02	1.66	<0.5
	8/20/02	No Flow						
	6/11/03	100	6.6	21.0	0.0	<0.3	<0.05	<0.5
	7/23/03	100	6.5	29.0	0.0	0.52	0.10	<0.5
	8/26/03	100	6.4	28.4	25.6	1.34	0.21	<0.5
	Average	68.50000	6.50000	32.22857	5.22857	1.25333	0.51200	<0.5
	St Dev	48.88251	0.54160	17.05303	9.87416	0.92919	0.76737	NA
Site	**Date**	**Flow (gpm)**	**pH**	**Alk (mg/L)**	**Acidity (mg/L)**	**Fe (mg/L)**	**Mn (mg/L)**	**Al (mg/L)**
3	6/13/01	40	7.6	46.0	0.0	0.61	<0.05	<0.5
Latitude:	7/18/01	60	7.0	64.0	0.0	0.98	0.31	<0.5
40-50-52	12/26/01		6.3	22.0	21.6	0.53	0.13	<0.5
Longitude:	6/13/02	150	6.8	34.0	0.0	0.87	0.46	<0.5
78-57-15	7/17/02	15	7.5	70.0	0.0	0.95	0.40	<0.5
	8/20/02	10	7.0	90.0	0.0	0.49	0.20	<0.5
	6/11/03	300	6.9	25.2	0.0	0.97	0.21	<0.5
	7/23/03	325	7.0	36.4	0.0	1.02	0.45	<0.5
	8/26/03	300	7.0	48.0	0.0	1.99	1.15	<0.5
	Average	150.00000	7.01111	48.40000	2.40000	0.93544	0.41350	ND
	St Dev	138.1769052	0.37896	22.45262	7.2	0.445995	0.321055	NA
Site	**Date**	**Flow (gpm)**	**pH**	**Alk (mg/L)**	**Acidity (mg/L)**	**Fe (mg/L)**	**Mn (mg/L)**	**Al (mg/L)**
2	6/13/01	75	7.6	52.0	0.0	<0.3	0.12	<0.5
Latitude:	7/18/01	80	6.9	56.0	0.0	<0.3	1.57	<0.5
40-50-22	12/26/01		6.5	30.0	0.0	<0.3	1.74	<0.5
Longitude:	6/13/02	450	6.9	34.0	0.0	0.34	1.98	<0.5
78-57-48	7/17/02	300	7.5	64.0	0.0	<0.3	1.27	<0.5
	8/20/02	325	6.9	78.0	0.0	<0.3	0.84	<0.5
	6/11/03	800	7.0	27.6	0.0	0.47	0.78	<0.5
	7/23/03	1100	7.2	43.2	0.0	0.47	0.92	<0.5
	8/26/03	1200	7.3	45.0	0.0	1.76	1.82	<0.5
	Average	541.25000	7.08889	47.75556	0.00000	0.76000	1.22622	ND
	St Dev	440.21707	0.34440	16.59692	0.00000	0.66923	0.60926	NA
Site	**Date**	**Flow (gpm)**	**pH**	**Alk (mg/L)**	**Acidity (mg/L)**	**Fe (mg/L)**	**Mn (mg/L)**	**Al (mg/L)**
1	6/13/01	700	7.8	52.0	0.0	<0.3	<0.05	<0.5
Latitude:	7/18/01	120	7.0	54.0	0.0	<0.3	0.26	<0.5
40-49-43	12/26/01		6.5	30.0	0.0	<0.3	1.43	<0.5
Longitude:	6/13/02	1200	7.0	32.0	0.0	<0.3	1.09	<0.5
78-57-39	7/17/02	600	7.6	60.0	0.0	<0.3	0.13	<0.5
Mouth of Brewer Run	8/20/02	600	6.9	76.0	0.0	<0.3	0.12	<0.5
	6/11/03	1200	7.2	26.8	0.0	0.59	0.76	<0.5

	7/23/03	1800	7.3	42.2	0.0	0.61	0.50	<0.5
	8/26/03	1900	7.5	41.2	0.0	2.57	1.63	1.27
	Average	1015.00000	7.20000	46.02222	0.00000	1.25567	0.73863	1.27000
	St Dev	622.50645	0.40000	16.02387	0.00000	1.13826	0.59063	NA

* Zero replaces less then detections in TMDL calculations

Attachment G

Comment and Response

No official comments were received on this TMDL.