Final

MILL CREEK WATERSHED TMDL

Schuylkill County

For Acid Mine Drainage Affected Segments

Prepared by:

Pennsylvania Department of Environmental Protection

March 8, 2005

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FIGURES

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ATTACHMENTS

[1]TMDL

Mill Creek Watershed
Schuylkill County, Pennsylvania

Table 1. 303(d) Sub-List								
State Water Plan (SWP) Subbasin: 03-A Mill Creek								
Year	**Miles**	**Segment ID Assessment ID**	**DEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	5.5	0452	02353	Mill Creek	CWF	305(b) Report	RE	Metals
1998	11.17	0452	02353	Mill Creek	CWF	SWMP	AMD	Metals
2002	11.2	20000510-1305-CJD	02353	Mill Creek	CWF	SWAP	AMD	Siltation
2002	1.2	20000706-1030-CJD	2354	Mill Creek (UNT)	CWF	SWAP	AMD	Siltation
2002	1.6	20000510-1305-CJD	2362	Mill Creek (UNT)	CWF	SWAP	AMD	Siltation
2002	0.5	20000510-1305-CJD	2363	Mill Creek (UNT)	CWF	SWAP	AMD	Siltation
2002	0.5	20000510-1305-CJD	2364	Mill Creek (UNT)	CWF	SWAP	AMD	Siltation
2002	0.8	20000510-1305-CJD	2365	Mill Creek (UNT)	CWF	SWAP	AMD	Siltation

Cold Water Fishery=CWF
Surface Water Monitoring Program = SWMP
Surface Water Assessment Program = SWAP
Resource Extraction = RE
Abandoned Mine Drainage = AMD
See Attachment D, *Excerpts Justifying Changes Between the 1996, 1998 and 2002 Section 303(d) Lists.*
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Mill Creek Watershed **(Attachment A)**. It was done to address the impairments noted on the 1996 Pennsylvania 303(d) list, required under the Clean Water Act, and covers one segment on this list (shown in Table 1). High levels of metals, and in some areas depressed pH, caused these impairments. All impairments resulted from acid drainage from abandoned coalmines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and pH.

[1] Pennsylvania's 1996, 1998 and 2002 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 1996 lawsuit settlement of *American Littoral Society and Public Interest Group of Pennsylvania v. EPA.*

Directions to the Mill Creek Watershed

Mill Creek watershed is approximately 17.2 square miles in area. It is located in central Schuylkill County, Pennsylvania and includes the communities of New Boston, Morea, St. Clair and Port Carbon. Mill Creek flows 11.2 miles south/southwest from its headwaters near Interstate 81 and Mahanoy City to its confluence with the Schuylkill River in Port Carbon. Mill Creek is assessable from Interstate 81 to S.R. 61 south of Frackville to the lower reach and S.R. 54 towards Mahanoy City to the headwaters.

Segments addressed in this TMDL

Mill Creek is affected by pollution from AMD. This pollution has caused high levels of metals in Mill Creek. Major sources of AMD occur at three (3) abandoned deep mine discharges named the Morea Overflow, Repplier/Buck Mountain, and Pine Forest. Mill Creek has been severely impacted by past mining and flows into abandoned deep mine workings near its headwaters. Mill Creek resurfaces at the Morea Overflow, which is approximately three (3) miles from the point the stream disappears.

There are a few active mining operations in the watershed. The three (3) major discharges in the watershed are all caused by abandoned mines and are treated as non - point sources. 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. See Table 4 for TMDL calculations and see Attachment C for TMDL explanations.

Clean Water Act Requirements

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

Additionally, the federal Clean Water Act and the U.S. Environmental Protection Agency's (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 non-point sources; and

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

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

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

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

Section 303(d) Listing Process

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

The primary method adopted by 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 stream segment can vary between sites. All the biological surveys included kick-screen sampling of benthic macroinvertebrates, habitat surveys, and

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

measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates are identified to the family level in the field.

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

Basic Steps for Determining a TMDL

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

1. Collection and summarization of pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculating TMDL for the waterbody using EPA approved methods and computer models;
3. Allocating pollutant loads to various sources;
4. Determining critical and seasonal conditions;
5. Public review and comment period on draft TMDL;
6. Submittal of final TMDL to EPA.
7. EPA approval of the TMDL.

Watershed History

The Mill Creek Watershed lies within the Anthracite Upland Section of the Ridge and Valley Province. The upper reach is within a small basin, known as the New Boston Basin, which is in the southern portion of the Western Middle Anthracite Field. The lower reach is in the central portion of the Southern Anthracite Field.

Approximately thirty-two percent (32%) of the area within the watershed is abandoned mine lands, including abandoned pits, deep mine openings, spoil piles, and refuse piles, which were affected and abandoned prior to State and Federal laws and regulations requiring reclamation of surface mines.

Due to the extensive mining, for more than 100 years, most of Mill Creek in the New Boston Basin has been eliminated. Above the disturbed area, streamflow disappears into abandoned deep mine workings approximately 1.4 miles from the headwater. Stream flow reappears at the Morea Overflow near the cogeneration plant operated by Wheelabrator Culm SVC, Inc.

The cogeneration plant is using the nearby piles of coal refuse for fuel and the coal ash, which is a byproduct is used to reclaim abandoned pits within the basin. The operator's reclamation goal is to ultimately restore Mill Creek.

Several water supply reservoirs are located outside the coalfields and are feeding tributaries that flow to Mill Creek.

In the lower reach of the watershed, additional sources of AMD reach Mill Creek. The main source of AMD is from two (2) large deep mine discharges known as the Repplier/Buck Mountain and Pine Forest.

The lower reach of the watershed contains the majority of the developed area, which accounts for about eight percent (8%) of the total area in the watershed and is mostly concentrated near Mill Creek.

There is another deep mine opening known as the St. Clair Shaft, located near the borough of St. Clair. Although, this opening, now sealed, is not discharging and has not discharged for over 50 years, it will discharge upon the cessation of active pumping of the underlying mine pool. The Reading Anthracite Coal Company, Inc. is pumping this mine pool in order to mine at their Wadesville Pit, a large open pit mine outside the watershed. The mine pool is pumped by large submersible pumps deep within an old mine shaft. The water is discharged into an unnamed tributary to the Schuylkill River. The discharge is authorized by an NPDES permit, which consistently meets effluent limits without treatment. Upon completion of the mining, the pumping will cease and the mine pool will flood and overflow at the St. Clair Shaft. The discharge will eventually reach Mill Creek via St. Clair's stormwater drainage network.

Table 2. Active Mining Permits in Mill Creek Watershed

Permit No.	*Operation and Company Name*	*Operation Status*
54020201	Stoudts Ferry Preparation Co., Inc. Mahanoy Twp Bank Mine	Active refuse reprocessing (spoil bank removal).
54840201	Pagnotti Enterprises, Inc. Shenandoah Area Mine	Active refuse reprocessing.
54950202	Gilberton Coal Co. N. Mahanoy Mine	Active refuse reprocessing and remining
54663021	Reading Anthracite Co. Potts Bannon P50 Mine	Active remining
54840106	Philadephia City Trustee Girard Estate Packer V Mine	Active remining, refuse reprocessing, coal ash and refuse placement

54900205	Wheelabrator Culm SVC, Inc. Morea Cogen	Active cogeneration plant, refuse reprocessing, coal ash placement
54813009	Joe Kuperavage Coal Co. E. Norwegian Mine	Active remining
54693047	Pagnotti Enterises, Inc. Morea & New Boston Mine	Active refuse reprocessing and coal ash placement

AMD Methodology

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

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

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

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

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

PR = required percent reduction for the current iteration

Cc = criterion in mg/l

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

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

Mean = average observed concentration

Standard Deviation = standard deviation of observed data

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

LTA = Mean * (1 – PR99) where (2)

LTA = allowable LTA source concentration in mg/l

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

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

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

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

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

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

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of applicable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for comparison between observed instream conditions and conditions that are expected to restore designated uses. The endpoint is based on either the narrative or numeric criteria available in water quality standards.

Because all of the pollution sources in the watershed are nonpoint sources, the TMDL is expressed as 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 3. Applicable Water Quality Criteria

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

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

TMDL Elements (WLA, LA, MOS)

$$TMDL = WLA + LA + MOS$$

A TMDL equation consists of a wasteload allocation, load allocation and a margin of safety. The wasteload allocation is the portion of the load assigned to point sources. The load allocation is the portion of the load assigned to non-point sources. The margin of safety is applied to account for uncertainties in the computational process. The margin of safety may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load). The TMDL allocations in this report are based on available data. Other allocation schemes could also meet the TMDL. Table 4 contains the TMDL component summary for each point evaluated in the watershed. Refer to the maps in Attachment A.

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 also take into account all upstream reductions. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. As changes occur in the watershed, the TMDLs may be re-evaluated to reflect current conditions. An implicit margin of safety (MOS) based on conservative assumptions in the 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 and each TMDL includes upstream loads.

Each permitted discharge in a segment is assigned a waste load allocation and the total waste load allocation for each segment is included in this table. There currently are no permitted discharges in the Mill Creek watershed. The difference between the TMDL and the WLA 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 to the area upstream of the point in order for water quality standards to be met at the point.

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

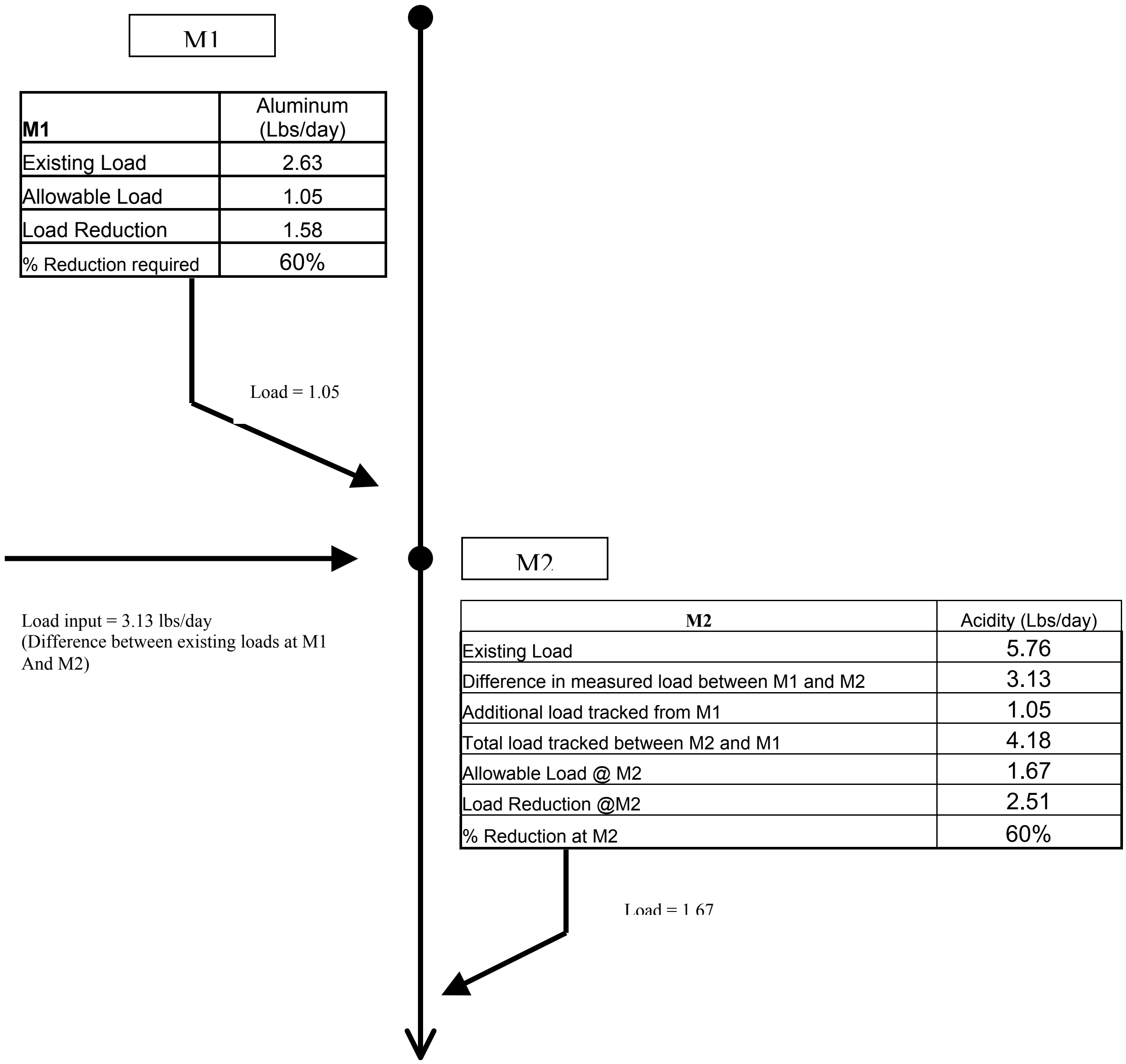
Table 4. Mill Creek Watershed Summary Table

Parameter	Existing Load (lbs/day)	TMDL Allowable Load (lbs/day)	WLA (lbs/day)	LA (lbs/day)	Load Reduction (lbs/day)	% Reduction
M1						
Aluminum (lbs/day)	2.63	1.1	0	1.1	1.58	60%
Iron (lbs/day)	0.99	0.99	0	NA	NA	NA
Manganese(lbs/day)	0.37	0.37	0	NA	NA	NA
Acidity (lbs/day)	282.83	4.6	0	4.6	278.22	98%
M2						
Aluminum (lbs/day)	5.76	1.7	0	1.7	2.51	60%
Iron (lbs/day)	2.10	2.10	0	NA	NA	NA
Manganese(lbs/day)	1.25	1.25	0	NA	NA	NA
Acidity (lbs/day)	236.51	20.4	0	20.4	0	0%*
M3						
Aluminum (lbs/day)	270.49	33.6	0	33.6	236.9	88%
Iron (lbs/day)	465.71	32.6	0	32.6	433.11	93%
Manganese(lbs/day)	101.04	43.5	0	43.5	57.59	57%
Acidity (lbs/day)	4454.16	0	0	0	4454.16	100%
M4						
Aluminum (lbs/day)	304.52	85.3	0	85.3	0	0%*
Iron (lbs/day)	223.78	111.9	0	111.9	0	0%*
Manganese(lbs/day)	121.27	110.4	0	110.4	0	0%*
Acidity (lbs/day)	9489.9	379.6	0	379.6	4440.03	92%
M4A						
Aluminum (lbs/day)	ND	NA	0	NA	NA	NA
Iron (lbs/day)	578.74	46.3	0	46.3	532.44	92%
Manganese(lbs/day)	166.37	31.6	0	31.6	134.76	81%
Acidity (lbs/day)	1627.81	862.7	0	862.7	765.07	47%
M5						
Aluminum (lbs/day)	8.57	3.3	0	3.3	5.31	62%
Iron (lbs/day)	293.42	16.8	0	16.8	276.64	94%
Manganese(lbs/day)	97.30	12.7	0	12.7	84.65	87%
Acidity (lbs/day)	895.49	411.9	0	411.9	483.56	54%
M6						
Aluminum (lbs/day)	394.56	138.1	0	138.1	31.90	19%
Iron (lbs/day)	1083.54	325.1	0	325.1	0	0%*
Manganese(lbs/day)	628.36	201.1	0	201.1	196.95	49%
Acidity (lbs/day)	10045.07	1305.9	0	1305.9	1383.25	6%

* Total of loads affecting this segment is less than the allowable load calculated at this point, therefore no reduction is necessary.
*ND = non detection   NA = not applicable

In the instance that the allowable load is equal to the measured load (e.g. manganese M2, Table 4), the simulation determined that water quality standards are being met instream and therefore no TMDL is necessary for the parameter at that point. Although no TMDL is necessary, the loading at the point is considered at the next downstream point. This is denoted as "NA" in the above table.

Following is an example of how the allocations, presented in Table 4, for a stream segment are calculated. For this example, aluminum allocations for M2 of Mill Creek are shown. As demonstrated in the example, all upstream contributing loads are accounted for at each point. Attachment C contains the TMDLs by segment analysis for each allocation point in a detailed discussion. These analyses follow the example. Attachment A contains maps of the sampling point locations for reference.



M1	Aluminum (Lbs/day)
Existing Load	2.63
Allowable Load	1.05
Load Reduction	1.58
% Reduction required	60%

M2	Acidity (Lbs/day)
Existing Load	5.76
Difference in measured load between M1 and M2	3.13
Additional load tracked from M1	1.05
Total load tracked between M2 and M1	4.18
Allowable Load @ M2	1.67
Load Reduction @M2	2.51
% Reduction at M2	60%

The allowable load tracked from M1 was 1.05 lbs/day. The existing load at M1 was subtracted from the existing load at M2 to show the actual measured increase of aluminum load that has entered the stream between these two sample points (3.13 lbs/day). This value was then added to the allowable load at M1 to calculate the total load that was tracked between M1 and M2 (allowable load @ M1 + the difference in existing load between M1 and M2). The total load tracked was then subtracted from the calculated allowable load at M2 to determine the amount of load to be reduced at M2. This value was found to be 4.18 lbs/day; it was 2.15 lbs/day greater then the M2 allowable load of 1.67 lbs/day. Therefore, a 60% reduction at M2 is necessary. From this point, the allowable load at M2 will be tracked to the next downstream point, M4.

Recommendations

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 BAMR, 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. Specially, BAMR has plans to restore Little Wolf Creek, a tributary to Mill Creek along with backfilling pits in that area.

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; and 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.

The Schuylkill Headwaters Association, Inc. (SHA) is a watershed group formed to tackle the huge AMD problems in the headwaters of the Schuylkill River. SHA maintains active membership with monthly work sessions, regular public meetings and implementation of group projects. SHA was awarded a 319 grant in 2003 to construct a passive AMD treatment system at the Pine Forest Discharge. This system consists of a flushable, anoxic limestone drain (ALD) followed by an aerobic wetland basin. The primary goal of the project is to eliminate the AMD from the Pine Forest Discharge.

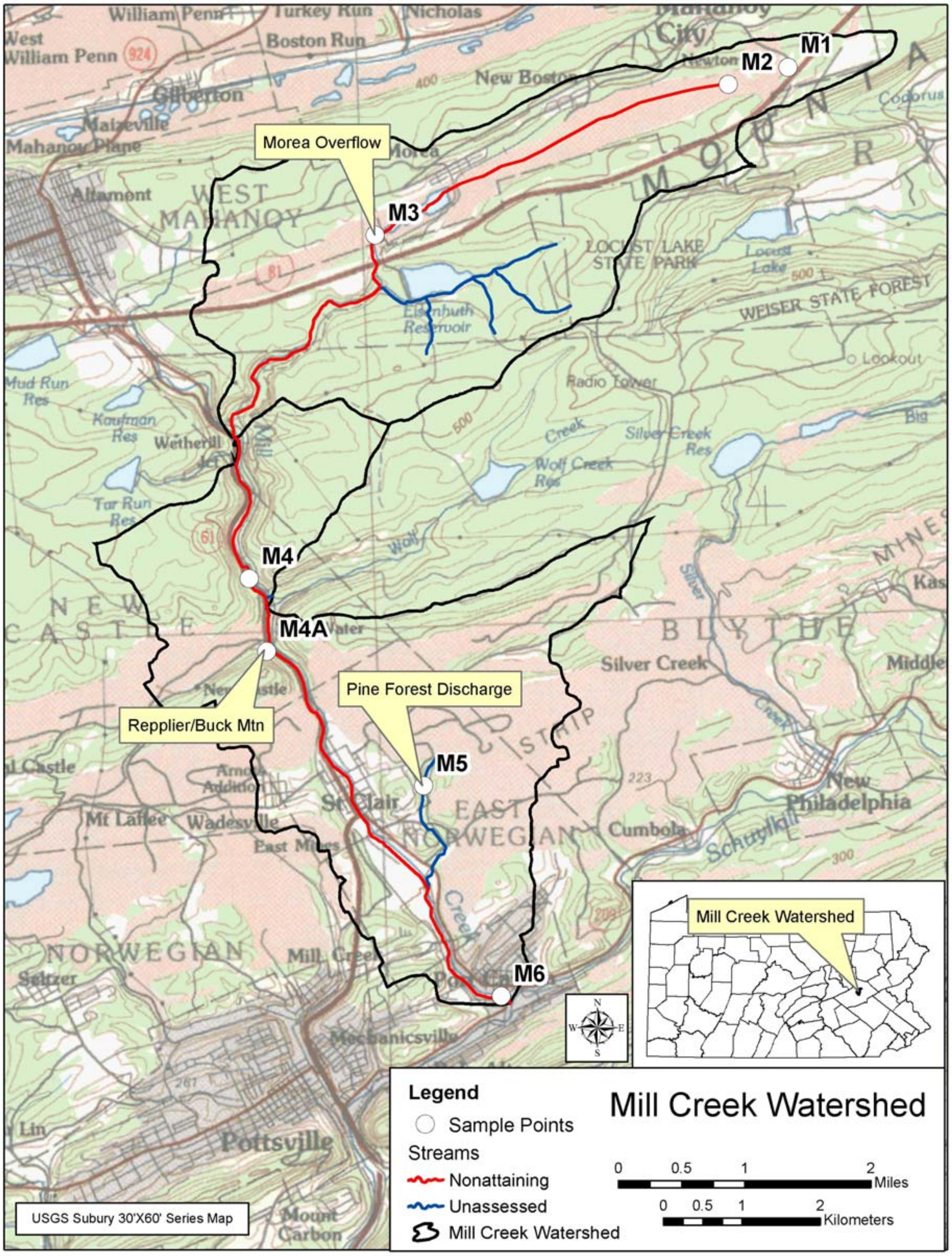
The coal industry, through DEP-promoted remining efforts, can help to eliminate some sources of AMD and conduct some of the remediation identified in the above recommendations through the permitting, mining, and reclamation of abandoned and disturbed mine lands. Special consideration should be given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

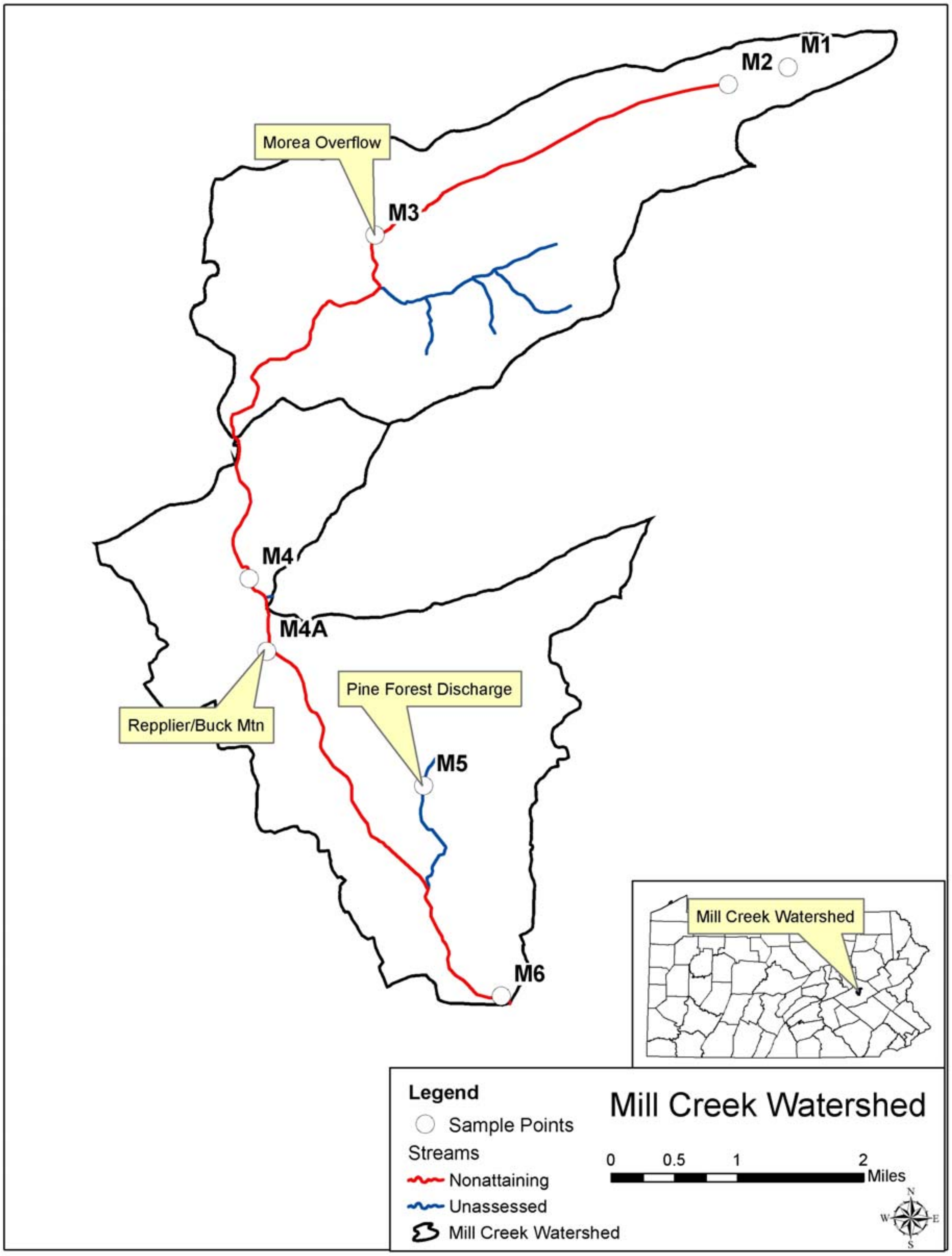
Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and the Pottsville Republican to foster public comment on the allowable loads calculated. A public meeting was held on November 16, 2004, at Schuylkill County Agricultural Center in Pottsville, PA, to discuss the proposed TMDL.

Attachment A

Mill Creek Watershed Map


Mill Creek Watershed
M1
M2
Morea Overflow
M3
M4
M4A
Repplier/Buck Mtn
Pine Forest Discharge
M5
M6
Mill Creek Watershed
Legend
Sample Points
Streams
Nonattaining
Unassessed
Mill Creek Watershed
0 0.5 1 2 Miles
0 0.5 1 2 Kilometers
USGS Subury 30'X60' Series Map


M1
M2
Morea Overflow
M3
M4
M4A
Repplier/Buck Mtn
Pine Forest Discharge
M5
M6
Mill Creek Watershed
Legend
Sample Points
Streams
Nonattaining
Unassessed
Mill Creek Watershed
Mill Creek Watershed
0
0.5
1
2
Miles

Attachment B

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

Method for Addressing Section 303(d) Listings for pH

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

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

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

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

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

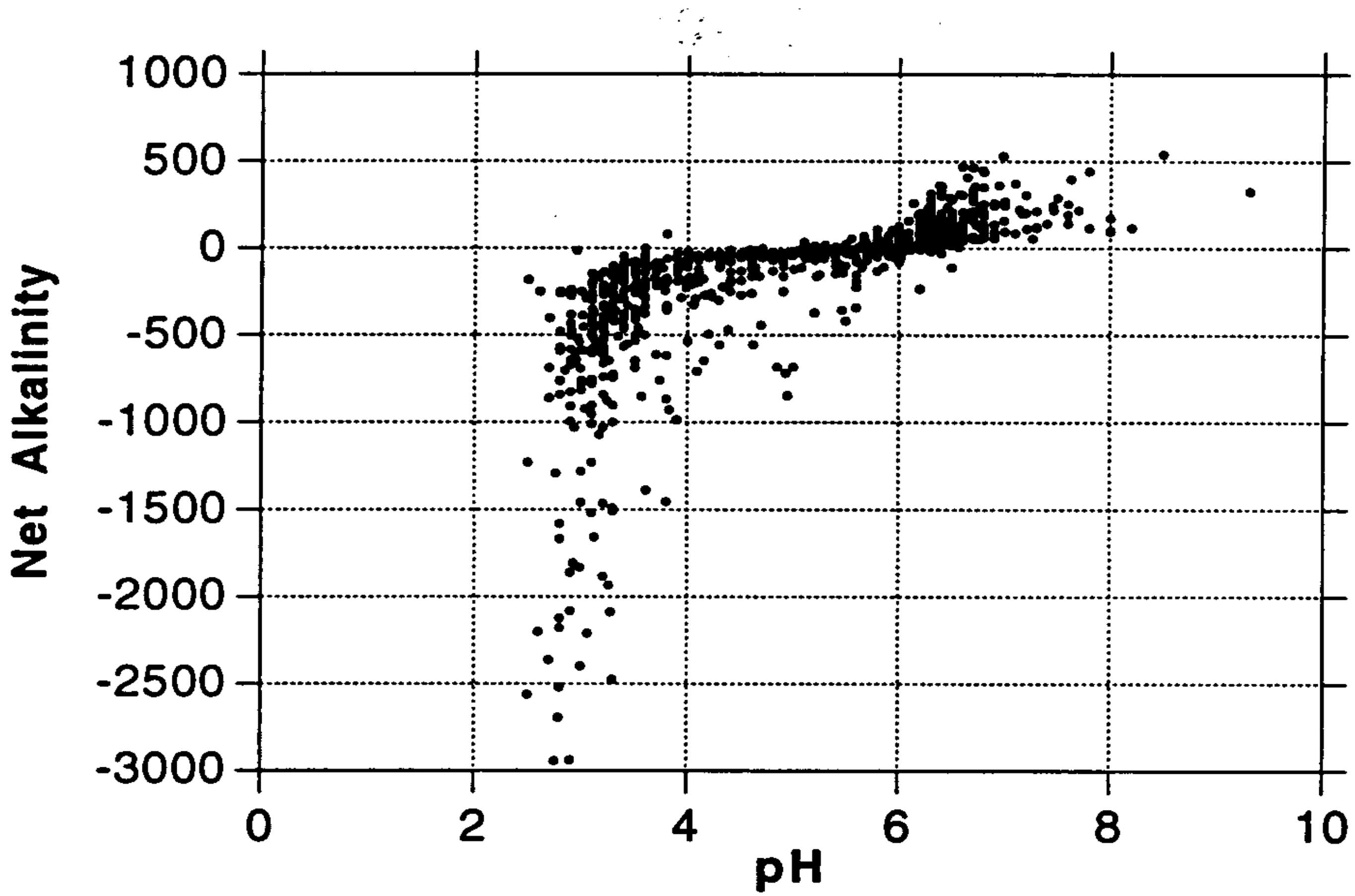


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

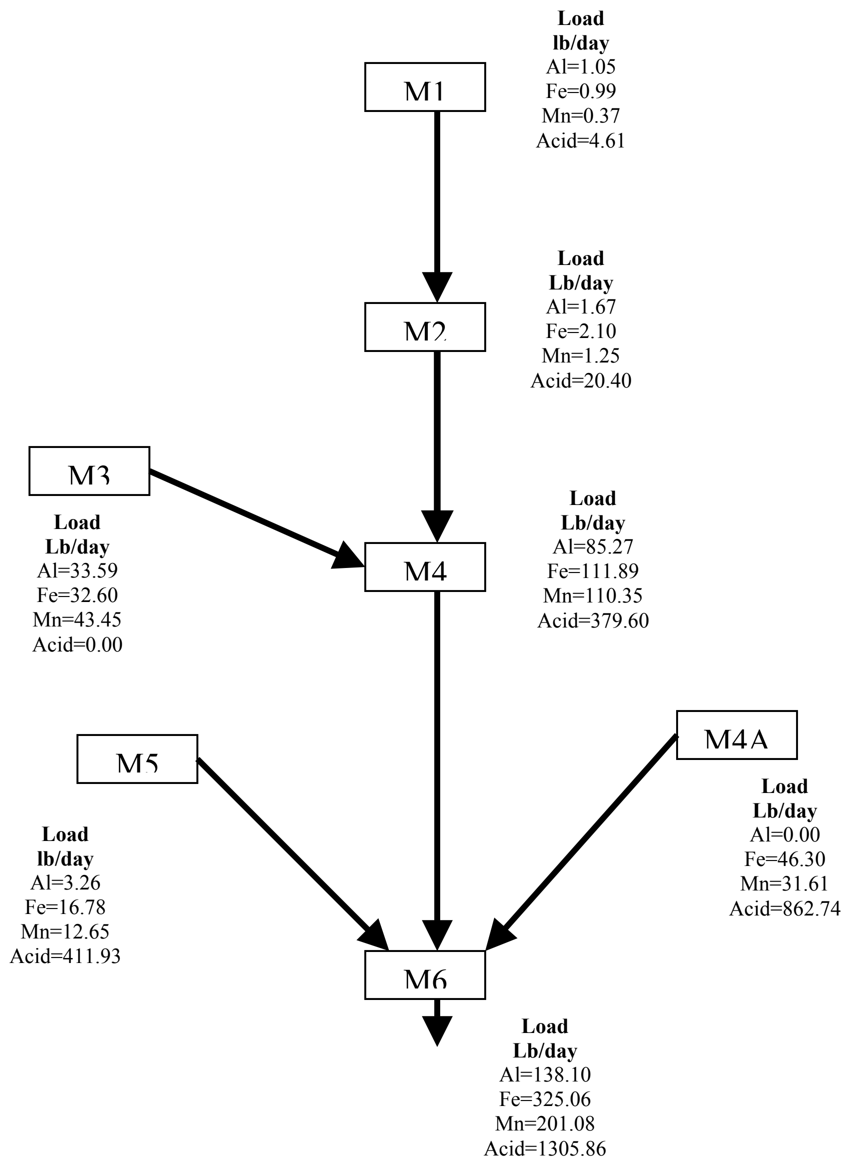
Attachment C
TMDLs By Segment

Mill Creek

The TMDL for Mill Creek consists of load allocations to four sampling sites along the stream (M1, M2, M4 and M6) and 3 abandoned mine discharges (M3, M4A and M5). Data sets include 8-9 samples taken roughly on the same days for each sample point, except for M4A, which has 5 samples taken. All sample points are shown on the maps included in Attachment A as well as on the allowable loading schematic on the following page.

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

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



<u>*TMDL calculations- M1-Headwaters of Mill Creek*</u>

The TMDL for sample point M1 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this headwaters segment was computed using water-quality sample data collected at point M1. The average flow, measured at the sampling point M1 (0.34 MGD), is used for these computations. The allowable load allocations calculated at M1 will directly affect the downstream point M2.

Sample data at point M1 shows that the headwaters of Mill Creek have a pH ranging between 5.0 and 7.1. Because of the high pH values, there currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH.

A TMDL for aluminum and acidity at M1 has been calculated. The measured sample data for iron and manganese were above detection limits but fell below applicable water quality criteria limits. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated.

Table C1 shows the measured and allowable concentrations and loads at M1. Table C2 shows percent reductions for aluminum and acidity required at this point.

Table C1		Measured		Allowable	
Flow (gpm)=	233.00	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	0.94	2.6	0.38	1.1
	Iron	0.35	1.0	0.35	1.0
	Manganese	0.13	0.4	0.13	0.4
ND = non detection	Acidity	101.08	282.8	1.65	4.6
NA = not applicable	Alkalinity	13.18	36.9		

Table C2. M1		
M1	Al (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M1	2.63	282.83
Allowable Load @ M1	1.05	4.61
Load Reduction @ M1	1.58	278.22
% Reduction required @ M1	60%	98%

TMDL calculations- M2 Mill Creek is lost to mine pool

The TMDL for sampling point M2 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point M2. The average flow, measured at the sampling point M2 (0.53 MGD), is used for these computations. The aluminum and acidic load calculated at M2 will directly affect the downstream point M4.

Sample data at point M2 shows pH ranging between 4.5 and 6.0; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

The measured and allowable loading for point M2 for aluminum and acidity was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The additional load from point M1 shows the total load that was permitted from upstream sources. This value was added to the difference in existing loads between point M1 and M2 to determine a total load tracked for the segment of stream between M2 and M1. This load will be compared to the allowable load to determine if further reductions are needed to meet the calculated TMDL at M2.

A TMDL for aluminum and acidity at M2 have been calculated. The measured sample data for iron and manganese were above detection limits but fell below applicable water quality criteria limits. Because water quality standards are met, a TMDL for these parameters isn't necessary and is not calculated.

Table C3 shows the measured and allowable concentrations and loads at M2. Table C4 shows the percent reduction needed for aluminum at this point.

Table C3		Measured		Allowable	
Flow (gpm)=	368.00	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	1.30	5.8	0.38	1.7
	Iron	0.48	2.1	0.48	2.1
	Manganese	0.28	1.3	0.28	1.3
ND = non detection	Acidity	53.51	236.5	4.62	20.4
NA = not applicable	Alkalinity	6.80	30.1		

Table C4. M2		
M2	Al (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M2	5.76	236.51
Difference in measured Loads between upstream loads and existing M2	3.13	-46.32
Percent loss due calculated at M2	NA	16%
Additional load tracked from above samples	1.05	4.61
Percentage of upstream loads that reach the M2	NA	84%
Total load tracked between M1 and M2	4.18	3.86
Allowable Load @ M2	1.67	20.40
Load Reduction @ M2	2.51	-16.54
% Reduction required at M2	60%	0%

The percent reduction required for acidity at M2 was calculated at 0. The upstream existing load for acidity from M1 was found to be greater than the existing load at sample point M2. The percent of upstream load that actually reach sample point M2 was calculated resulting in a value for percent loss of upstream load that occurs before the load reaches this sample point. Therefore this loss is considered in the reductions at M2. A loss of 46.32 lbs between the upstream point and M2 results in a 16% loss of acidic load in this segment of stream. The total acidic load tracked from upstream was found to be 3.86 lbs/day, less then the allowable load calculated at M2 resulting in no reduction required.

TMDL calculations- M3 Morea AMD Discharge, Stream reappears

The TMDL for sample point M3 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point M3. The average flow, measured at the sampling point M3

(7.40 MGD), is used for these computations. The allowable load calculated at M3 will directly affect the downstream point M4.

Sample data at point M3 shows pH ranging between 3.7 and 4.0; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

Table C5 shows the measured and allowable concentrations and loads at M3. Table C6 shows the percent reduction for all parameters required at this point.

Table C5		Measured		Allowable	
Flow (gpm)=	5136.89	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	4.38	270.5	0.54	33.6
	Iron	7.55	465.7	0.53	32.6
	Manganese	1.64	101.0	0.70	43.5
	Acidity	72.20	4454.2	0.00	0.0
	Alkalinity	0.36	21.9		

Table C6. M3				
M3	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M3	270.49	465.71	101.04	4454.16
Allowable Load @ M3	33.59	32.60	43.45	0.00
Load Reduction @ M3	236.90	433.11	57.59	4454.16
% Reduction required @ M3	88%	93%	57%	100%

TMDL Calculation –M4 Mill Creek above confluence with Wolf Creek

The TMDL for sampling point M4 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point M4. The average flow, measured at the sampling point M4 (21.85 MGD), is used for these computations. The existing load allocations calculated at M4 will directly affect the downstream point M6.

Sample data at point M4 shows pH ranging between 4.1 and 4.6; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

The measured and allowable loading for point M4 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 allowable loads already specified from upstream sources. The existing load from points M3 and M2 show the total load that was permitted from upstream sources. This value, for each parameter, was subtracted from the actual load at point M4 to determine a remaining allowable load for the segment of stream between M3 – M2 and M4. This remaining load will determine if further reductions are needed to meet the calculated TMDL at M4.

Table C7 shows the measured and allowable concentrations and loads at M4. Table C8 shows the percent reduction for acidity needed at M4.

Table C7		Measured		Allowable	
Flow (gpm)=	15176.56	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	1.67	304.5	0.47	85.3
	Iron	1.23	223.8	0.61	111.9
	Manganese	0.67	121.3	0.61	110.4
	Acidity	52.07	9489.9	2.08	379.6
	Alkalinity	3.93	716.9		

Table C8. M4				
M4	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M4	304.52	223.78	121.27	9489.90
Difference in measured Loads between upstream loads and M4	28.27	-241.93	20.23	4799.23
Percent loss due calculated at M4	NA	52%	NA	NA
Additional load tracked from above samples	35.26	32.60	43.45	20.40
Percentage of upstream loads that reach the M4	NA	48%	NA	NA
Total load tracked between M2/M3 and M4	63.53	15.66	63.68	4819.63
Allowable Load @ M4	85.27	111.89	110.35	379.60
Load Reduction @ M4	-21.74	-96.23	-46.67	4440.03
% Reduction required at M4	0%	0%	0%	92%

The percent reduction for iron at M4 was calculated at 0. The upstream existing iron loads from M3 and M2 were summed and found to be greater than the existing iron load at sample point M4. The percent of upstream load that actually reaches sample point M4 was calculated resulting in a value for percent loss of upstream load that occurs before the iron load reaches this sample point. Therefore this loss is considered in the reductions at M4. A loss of 241.93 lbs of iron between upstream points and M4 results in a 52% loss in this segment of stream. This large loss can be attributed to a very sizable amount of iron dropping out in the stream segment between M3- M2 and M4. The total loads tracked for aluminum and manganese were less then the calculated allowable loads at M4, resulting in no reductions. The acidic value tracked was 4440.03 lbs/day greater than the allowable acidic load at M4 calculating a 92% reduction.

TMDL calculations- M4A Repplier Abandoned Deep Mine Discharge

The TMDL for sample point M4A consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point M4A. The average flow, measured at the sampling point

M4A (4.39 MGD), is used for these computations. The allowable load calculated at M4A will directly affect the downstream point M6.

Sample data at point M4A shows pH ranging between 6.1 and 6.4; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

A TMDL for iron, manganese and acidity at M4A has been calculated. All measured sample data for aluminum fell below detection limits. Because water quality standards are met, a TMDL for aluminum isn't necessary and is not calculated. Aluminum's existing load values at M4A in Table C9 will be denoted as "NA". Loads from M4A will be calculated in the TMDLs at the downstream point M6.

Table C9 shows the measured and allowable concentrations and loads at M4A. Table C10 shows the percent reductions for iron, manganese and acidity that are needed at M4A.

Table C9		Measured		Allowable	
Flow (gpm)=	3050.00	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	ND	NA		
	Iron	15.80	578.7	1.26	46.3
	Manganese	4.54	166.4	0.86	31.6
ND = non detection	Acidity	44.44	1627.8	23.55	862.7
NA = not applicable	Alkalinity	41.36	1515.0		

TableC10. M4A			
M4A	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M4A	578.74	166.37	1627.81
Allowable Load @ M4A	46.30	31.61	862.74
Load Reduction @ M4A	532.44	134.76	765.07
% Reduction required @ M4A	92%	81%	47%

TMDL calculations- M5 Pine Forest Discharge

The TMDL for sample point M5 consists of a load allocation to all of the area at and above this point shown in Attachment A. The load allocation for this segment was computed using water-quality sample data collected at point M5. The average flow, measured at the sampling point M5 (2.01 MGD), is used for these computations. The allowable load calculated at M5 will directly affect the downstream point M6.

Sample data at point M5 shows pH ranging between 5.6 and 5.9; pH will be addressed as part of this TMDL. There currently is not an entry for this segment on the Section Pa 303(d) list for impairment due to pH.

Table C11 shows the measured and allowable concentrations and loads at M5. Table C12 shows the percent reductions for all parameters that are required at M5.

Table C11		Measured		Allowable	
Flow (gpm)=	1393.44	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	0.51	8.6	0.19	3.3
	Iron	17.53	293.4	1.00	16.8
	Manganese	5.81	97.3	0.76	12.7
	Acidity	53.51	895.5	24.62	411.9
	Alkalinity	39.29	657.5		

Table C12. M5				
M5	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M5	8.57	293.42	97.30	895.49
Allowable Load @ M5	3.26	16.78	12.65	411.93
Load Reduction @ M5	5.31	276.64	84.65	483.56
% Reduction required @ M5	62%	94%	87%	54%

TMDL Calculation – M6 The mouth of Mill Creek before it enters Schuylkill River

The TMDL for sampling point M6 on Mill Creek consists of a load allocation of the entire area above point M6 as shown in Attachment A. The load allocation for this stream segment was computed using water-quality sample data collected at point M6. The average flow, measured at the sampling point M6 (42.02 MGD), is used for these computations.

There currently is not an entry for this segment on the Pa Section 303(d) list for impairment due to pH. Sample data at point M6 shows pH ranging between 5.8 and 6.8; pH will be addressed as part of this TMDL.

The measured and allowable loading for point M6 for all parameters was computed using water-quality sample data collected at the point. This was based on the sample data for the point and did not account for any loads already specified from upstream sources. The load from points M4, M4A and M5 show the total load that was permitted from upstream sources. This value, was subtracted from the existing load at point M6 to determine a remaining existing load for the segment of stream between M4, M4A – M5 and M6. This remaining load will determine if further reductions are needed to meet the calculated TMDL at M6.

Table C13 shows the measured and allowable concentrations and loads at M6. Table C14 shows the percent reductions required for aluminum, manganese and acidity at sample point M6.

Table C13		Measured		Allowable	
Flow (gpm)=	29177.44	Concentration	Load	Concentration	Load
		mg/L	lbs/day	mg/L	lbs/day
	Aluminum	1.13	394.6	0.39	138.1
	Iron	3.09	1083.5	0.93	325.1
	Manganese	1.79	628.4	0.57	201.1
	Acidity	28.67	10045.1	3.73	1305.9
	Alkalinity	14.71	5154.9		

Table C14. M6				
M6	Al (Lbs/day)	Fe (Lbs/day)	Mn (Lbs/day)	Acidity (Lbs/day)
Existing Load @ M6	394.56	1083.54	628.36	10045.07
Difference in measured Loads between the upstream loads and M6	81.47	-12.40	243.42	-1968.13
Percent loss due calculated at M6	NA	1%	NA	16%
Additional load tracked from above samples	88.53	174.97	154.61	1654.27
Percentage of upstream loads that reach the M6	NA	99%	NA	84%
Total load tracked between M4/M4A/M5 and M6	170.00	172.99	398.03	1383.25
Allowable Load @ M6	138.10	325.06	201.08	1305.86
Load Reduction @ M6	31.90	-152.07	196.95	77.39
% Reduction required at M6	19%	0%	49%	6%

The percent reduction for iron at M6 was found to be 0. The upstream existing loads for iron and acidity from M4, M4A and M5 were found to be greater than the existing loads at sample point M6. The percent of upstream loads that actually reach sample point M6 were calculated resulting in values for percent loss of upstream loads that occur before the loads reach this sample point. Therefore these losses are considered in the reductions at M6. A loss of 12.40 lbs of iron between the upstream points and M6 results in a 1% loss of load in this segment of stream. A loss of 1968.13 lbs of acidity between the upstream points and M6 results in a 16% loss of acidic load in this segment of stream. The total loads tracked from upstream for aluminum, manganese and acidity were found to be greater than the calculated allowable loads at M6, and therefore reductions were necessary at this sample point.

Margin of Safety

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

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

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

Seasonal Variation

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

Critical Conditions

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

Attachment D

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

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

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

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

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

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

Attachment E

Water Quality Data Used In TMDL Calculations

Date	Coll by	MP Id	Flow (gpm)	Temp (C)	pH	Al (UG/L)	ALK (MG/L)	FE (UG/L)	HOT A (MG/L)	MN (UG/L)
8/8/2002	DEP	M1	10.00		7.10	500.00	48.00	300.00	0.00	107.00
10/2/2002	DEP	M1	84.00		5.60	744.00	8.20	300.00	40.00	130.00
10/31/2002	DEP	M1	394.00		6.40	1070.00	12.40	522.00	555.60	141.00
12/17/2002	DEP	M1	274.00		5.10	940.00	6.40	300.00	41.40	136.00
1/9/2003	DEP	M1	274.00	3.00	5.00	994.00	6.60	300.00	50.00	145.00
4/3/2003	DEP	M1	423.00	12.60	5.90	1430.00	8.40	798.00	43.40	160.00
5/1/2003	DEP	M1	119.00	13.40	5.10	1200.00	6.40	300.00	34.40	122.00
6/26/2003	DEP	M1	286.00	21.00	5.30	644.00	9.00	ND	43.80	126.00
average			233.00	12.50	5.69	940.25	13.18	402.86	101.08	133.38
st dev			147.8986	7.378347	0.743424	304.0553	14.20963	192.8863	184.2985	16.03512
Date	Coll by	MP Id	Flow (gpm)	Temp (C)	pH	Al (UG/L)	ALK (MG/L)	FE (UG/L)	HOT A (MG/L)	MN (UG/L)
10/2/2002	DEP	M2	168.00		5.40	799.00	7.40	328.00	36.60	268.00
10/31/2002	DEP	M2	299.00	6.00	6.00	964.00	7.40	509.00	61.80	252.00
12/17/2002	DEP	M2	519.00		4.80	1340.00	5.80	414.00	54.20	256.00
1/9/2003	DEP	M2	445.00	3.00	4.50	2110.00	6.80	552.00	63.20	349.00
4/3/2003	DEP	M2	532.00	13.40	5.30	1280.00	6.20	536.00	46.00	263.00
5/1/2003	DEP	M2	143.00	13.80	4.80	1370.00	5.80	378.00	57.20	335.00
6/26/2003	DEP	M2	470.00	24.10	4.90	1260.00	8.20	613.00	55.60	261.00
average			368.00	12.06	5.10	1303.29	6.80	475.71	53.51	283.43
st dev			164.0203	8.194388	0.503322	414.0091	0.916515	103.7508	9.340134	40.53335
Date	Coll by	MP Id	Flow (gpm)	Temp (C)	pH	Al (UG/L)	ALK (MG/L)	FE (UG/L)	HOT A (MG/L)	MN (UG/L)
8/8/2002	DEP	M3	1041.00		4.00	3420.00	2.00	7980.00	80.60	1340.00
9/10/2002	DEP	M3	177.00	3.00	4.00	4790.00	1.20	11100.00	72.00	1880.00
10/2/2002	DEP	M3	1797.00		3.90	5630.00	0.00	13100.00	94.00	2140.00
10/31/2002	DEP	M3	3791.00		3.90	4510.00	0.00	10800.00	89.60	1790.00
12/17/2002	DEP	M3	7169.00		3.70	4300.00	0.00	8780.00	72.00	1600.00
1/9/2003	DEP	M3	5625.00		3.70	4400.00	0.00	6290.00	72.00	1570.00
4/3/2003	DEP	M3	9772.00	11.40	3.80	4400.00	0.00	2990.00	56.40	1520.00
5/1/2003	DEP	M3	5023.00	11.20	3.70	4310.00	0.00	3470.00	53.00	1570.00
6/26/2003	DEP	M3	11837.00	17.70	3.70	3700.00	0.00	3430.00	60.20	1330.00
average			5136.89	10.83	3.82	4384.44	0.36	7548.89	72.20	1637.78
st dev			3954.42	6.026815	0.130171	626.8395	0.733333	3736.096	14.19049	260.2776
Date	Coll by	MP Id	Flow (gpm)	Temp (C)	pH	Al (UG/L)	ALK (MG/L)	FE (UG/L)	HOT A (MG/L)	MN (UG/L)
8/8/2002	DEP	M4	2757.00		4.20	1600.00	4.80	300.00	64.20	694.00
9/10/2002	DEP	M4	1723.00		4.60	987.00	5.60	783.00	46.40	468.00
10/2/2002	DEP	M4	4214.00		4.30	2150.00	5.00	1090.00	66.40	920.00
10/31/2002	DEP	M4	9150.00		4.20	2100.00	3.60	1580.00	59.60	851.00
12/17/2002	DEP	M4	28675.00		4.40	1320.00	4.00	2010.00	30.00	489.00
1/9/2003	DEP	M4	19728.00		4.10	1840.00	2.40	1510.00	63.20	652.00
4/3/2003	DEP	M4	28378.00	11.60	4.30	1680.00	2.80	1790.00	34.60	620.00
5/1/2003	DEP	M4	9964.00	11.90	4.10	1840.00	1.80	1030.00	46.00	719.00
6/26/2003	DEP	M4	32000.00	18.70	4.20	1520.00	5.40	957.00	58.20	575.00

average			15176.56	14.07	4.27	1670.78	3.93	1227.78	52.07	665.33
st dev			12140.54	4.015387	0.158114	369.0501	1.374773	538.713	13.37871	151.4332
Date	**Coll by**	**MP Id**	**Flow (gpm)**	**Temp (C)**	**pH**	**Al (UG/L)**	**ALK (MG/L)**	**FE (UG/L)**	**HOT A (MG/L)**	**MN (UG/L)**
12/17/2002	DEP	M4A	2772.00		6.10	ND	40.00	17600.00	35.20	4350.00
1/9/2003	DEP	M4A	3144.00		6.40	ND	39.60	16000.00	50.20	4200.00
4/3/2003	DEP	M4A	3555.00	12.60	6.30	ND	40.80	16000.00	34.60	4800.00
5/1/2003	DEP	M4A	1195.00	12.30	6.20	ND	42.20	14400.00	40.40	4620.00
6/26/2003	DEP	M4A	4584.00	15.10	6.30	ND	44.20	15000.00	61.80	4740.00
average			3050.00	13.33	6.26	NA	41.36	15800.00	44.44	4542.00
st dev			1238.479511	1.53731	0.11402	NA	1.87297	1216.552506	11.5442	257.721
Date	**Coll by**	**MP Id**	**Flow (gpm)**	**Temp (C)**	**pH**	**Al (UG/L)**	**ALK (MG/L)**	**FE (UG/L)**	**HOT A (MG/L)**	**MN (UG/L)**
8/8/2002	DEP	M5	1579.00		5.90	ND	42.00	19700.00	59.20	6130.00
9/10/2002	DEP	M5	1175.00		5.80	ND	42.00	17200.00	49.40	5250.00
10/2/2002	DEP	M5	1516.00		5.90	ND	42.00	23700.00	64.60	7290.00
10/31/2002	DEP	M5	1228.00		5.80	602.00	42.00	20000.00	69.60	6230.00
12/17/2002	DEP	M5	1708.00		5.60	816.00	38.00	17900.00	52.40	5860.00
1/9/2003	DEP	M5	1425.00		5.70	810.00	39.20	16000.00	53.00	5670.00
4/3/2003	DEP	M5	1178.00	13.30	5.70	891.00	34.80	14400.00	33.60	5530.00
5/1/2003	DEP	M5	1286.00	13.90	5.70	664.00	37.60	15300.00	40.20	5420.00
6/26/2003	DEP	M5	1446.00	16.10	5.80	826.00	36.00	13600.00	59.60	4950.00
average			1393.44	14.43	5.77	768.17	39.29	17533.33	53.51	5814.44
st dev			188.8135	1.474223	0.1	110.3928	2.848001	3195.309	11.41977	686.9154
Date	**Coll by**	**MP Id**	**Flow (gpm)**	**Temp (C)**	**pH**	**Al (UG/L)**	**ALK (MG/L)**	**FE (UG/L)**	**HOT A (MG/L)**	**MN (UG/L)**
8/8/2002	DEP	M6	4498.00	6.00	6.50	624.00	19.40	2570.00	0.00	2570.00
9/10/2002	DEP	M6	3751.00		6.80	500.00	28.00	1680.00	0.00	1880.00
10/2/2002	DEP	M6	7542.00		6.70	1310.00	22.00	3570.00	0.00	2070.00
10/31/2002	DEP	M6	14815.00		6.40	1240.00	13.20	3070.00	48.00	1420.00
12/17/2002	DEP	M6	53751.00		5.90	1100.00	8.80	3380.00	32.80	969.00
1/9/2003	DEP	M6	37710.00		6.20	1440.00	10.60	3870.00	47.60	1530.00
4/3/2003	DEP	M6	49411.00	12.90	6.10	1180.00	9.80	3300.00	41.80	1610.00
5/1/2003	DEP	M6	21119.00	15.60	6.10	1310.00	10.00	3510.00	36.00	2020.00
6/26/2003	DEP	M6	70000.00	20.30	5.80	1430.00	10.60	2880.00	51.80	2070.00
average			29177.44	13.70	6.28	1126.00	14.71	3092.22	28.67	1793.22
st dev			24360.4	5.974948	0.345607	338.9676	6.791989	656.3493	22.29372	465.9731

ND =Nondetect

Attachment F
Comment and Response

No official comments were received during the public comment period.