BENNETT BRANCH SINNEMAHONING CREEK WATERSHED TMDL

Cameron, Clearfield, and Elk Counties

For Mine Drainage Affected Segments

Prepared for:

Pennsylvania Department of Environmental Protection

September 1, 2008

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Cameron, Clearfield, and Elk Counties, Pennsylvania

Introduction

This report presents the Total Maximum Daily Loads (TMDLs[1]) developed for impaired segments in the Bennett Branch Sinnemahoning Creek Watershed (Bennett Branch) (Attachment A). These were done to address the impairments noted on the 1996 Pennsylvania (PA) Section 303(d) list of impaired waters, required under the Clean Water Act, and covers two segments on that list and one segment on a later list/report (Table 1). Bennett Branch is listed as impaired for metals and pH. All impairments resulted from drainage from abandoned coal mines. The TMDL addresses the three primary metals associated with abandoned mine drainage (AMD) (iron, aluminum, and manganese) and pH.

Table 1. 303(d) Listed Segments

State Water Plan (SWP) Subbasin: 08A										
HUC: 02050202 Bennett Branch Sinnemahoning Creek										
Year	**Miles**	**Use Designation**	**Assessment ID**	**Segment ID**	**PADEP Stream Code**	**Stream Name**	**Designated Use**	**Data Source**	**Source**	**EPA 305(b) Cause Code**
1996	23.06	Aquatic Life	7999	7144	24508	Bennett Branch Sinnemahoning Creek	WWF	305(b) Report	AMD	Metals
2002	4.92	Aquatic Life	2800	20010906-1040-JLR	24508	Bennett Branch Sinnemahoning Creek	CWF, WWF	SWA	AMD	pH

AMD = Abandoned Mine Drainage
CWF = Cold Water Fishery
SWA = Surface Water Assessment
WWF = Warm Water Fishery
See Attachment E, *Excerpts Justifying Changes Between the 1996, 1998, and 2002Section 303(d) Lists and Integrated Report Lists (2004, 2006).*
The use designations for the stream segments in this TMDL can found in PA Title 25 Chapter 93.

Directions to the Bennett Branch Watershed

The watershed is located on the U.S. Geological Survey 7.5 minute quadrangles of Brandy Camp, Cameron, Dents Run, Devils Elbow, Driftwood, Huntley, Kersey, Penfield, Rathburn, Sabula, St. Marys, The Knobs, Weedville, and West Creek. The headwaters of Bennett Branch are located in northern Clearfield County. The confluence of the North and South Branches of Bennett Branch occur near the town of Winterburn, Clearfield County. From the confluence of these two headwater branches, the Bennett Branch flows northeast into Elk County, where a majority of the watershed is located. The Bennett Branch continues flowing northeast into Cameron County where it turns to flow east-southeast to its confluence with the Driftwood Branch Sinnemahoning Creek (Driftwood Branch) in the Borough of Driftwood, Cameron

[1] Pennsylvania's 1996, 1998, and 2002 Section 303(d) lists and the Integrated Report Lists (2004, 2006) were approved by the U.S. Environmental Protection Agency (USEPA). The 1996 Section 303(d) list provides the basis for measuring progress under the 1997 lawsuit settlement of *American Littoral Society and the Public Interest Group of Pennsylvania v. EPA*.

County. The major tributaries to Bennett Branch include: North Branch Bennett Branch, South Branch Bennett Branch, Heath Run, Bark Camp Run, Mountain Run, Matley Run, Wilson Run, Moose Run, Horning Run, Mill Run, Tyler Run, Cherry Run, Kersey Run, Laurel Run, Caledonia Run, Bakemans Run, Medix Run, Silvermill Hollow Run, Trout Run, Jimmy Run, Wainwright Run, Charly's Run, Dents Run, Hicks Run, Beaverdam Run, Barrs Run, Miller Run, Stone Quarry Run, Mix Run, Little Dent Run, Nanny Run, and Bayer Run. The largest towns in the watershed include Penfield and Mill Run in Clearfield County; Force, Weedville, Benezette, and Dents Run in Elk County; and Driftwood in Cameron County. Four major highways provide access to the Bennett Branch Watershed (Attachment A). State Routes (SR) 255 and 555 parallel the Bennett Branch mainstem until Weedville where SR555 splits off and continues to parallel the mainstem, while SR255 travels north out of the watershed. SR153 travels from north to south through Penfield in the headwaters of the Bennett Branch Watershed. SR2004 (Quehanna Highway) intersects with SR555 in the town of Medix Run and travels along the mainstem of Medix Run for a short length before turning east to travel along the southwestern boundary of the watershed to its eventual exit. Numerous township roads provide access to Bennett Branch and its tributaries.

Hydrology and Geology

The headwaters of Bennett Branch are located in northern Clearfield County. The confluence of the North and South Branches of Bennett Branch occur near the town of Winterburn, Clearfield County. From the confluence of these two headwater branches, the Bennett Branch flows northeast into Elk County, where a majority of the watershed is located. The Bennett Branch continues flowing northeasterly into Cameron County where it turns to flow east-southeast to its confluence with the Driftwood Branch in the Borough of Driftwood, Cameron County. The Bennett Branch Watershed contains approximately 366.12 square miles and 669.16 stream miles. The Bennett Branch mainstem flows through the towns of Winterburn, Penfield, Mill Run, Hollywood, Tyler, Force, Weedville, Caledonia, Medix Run, Benezette, Sumerson, Grant, Dents Run, Hicks Run, Mix Run, Castle Garden, and Driftwood. The total length of the mainstem is approximately 38 miles.

The Bennett Branch Watershed lies within the Pittsburgh Low Plateau and the Deep Valleys Sections of the Appalachian Plateaus Physiographic Province. There is a vertical drop in the watershed of about 900 feet from its headwaters to the mouth. The average annual precipitation is 45 inches. The region is characterized by warm summers and long, cold winters. Temperatures change frequently and sometimes rapidly.

The watershed is dominated by forestland. Forestlands comprise slightly over 90 percent of the land use in the Bennett Branch Watershed. Agriculture is a distant second, accounting for nearly 6 percent of the land use. The remaining 4 percent is a mix of transitional land use (2.62 percent), quarries and coal mines (0.60 percent), low density development (0.50 percent), and water (0.26 percent).

The Bennett Branch Watershed is primarily composed of four geological formations. The Pottsville Formation covers the largest portion of the watershed at 39 percent. The next prevalent formation is the Huntley Mountain Formation, covering 17 percent of the watershed.

The Allegheny Formation, containing the mineable seams of coal, constitutes 15.5 percent of the watershed. The Shenango Formation, the last prevalent formation, covers 15 percent of the watershed. The final 13.5 percent is comprised of the Glenshaw Formation (7 percent), the Catskill Formation (5 percent), and the Casselman Formation (1.5 percent). The watershed is primarily composed of sandstone (91.5 percent) and, to a lesser extent, shale (8.5 percent).

There are four predominant soil associations in the Bennett Branch Watershed. The most predominant soil association is the Buchanan-Hartleton-Hazleton covering 39 percent of the watershed. The Hazleton-Cookport-Ernest association covers another 29 percent of the watershed. The Leck Kill-Hartleton-Albrights and Gilpin-Ernest-Cavode associations cover another 15 percent and 12 percent of the watershed, respectively. The remaining 6 percent contains either the Hazleton-Dekalb-Buchanan or Tilsit-Brinkerton-Buchanan associations.

Segments Addressed in this TMDL

Bennett Branch is affected by pollution from AMD. This pollution has caused high levels of metals and in some cases, low pH in the watershed. There are no active mining operations in the TMDL segment of the Bennett Branch Watershed. All active mining operations have been accounted for in previous TMDLs completed on Bennett Branch subwatersheds, or are located in a subwatershed that will have a future TMDL completed. There is, however, one industrial wastewater facility National Pollutant Discharge Elimination System (NPDES) permit held by the Jay Township Water Authority (NPDES PA 0222500) that has effluent limits placed on total iron, manganese, and aluminum.

The TMDLs will be expressed as long-term average loadings. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average gives a better representation of the data used for the calculations. See Attachment D for an explanation of TMDL calculations.

This AMD TMDL document contains one or more future mining Waste Load Allocation (WLA). This (these) WLA(s) were requested by the (Knox, Moshannon, Greensburg, Cambria, or Pottsville) District Mining Office (DMO) to accommodate one or more future mining operations. The DMO determined the number and location of the future mining WLAs. This will allow speedier approval of future mining permits without the time-consuming process of amending this TMDL document. All comments and questions concerning the future mining WLAs in this TMDL are to be directed to the appropriate DMO. Future wasteload allocations are calculated using the method described for quantifying pollutant load in Attachment C.

The following are examples of what is or is not intended by the inclusion of future mining WLAs. This list is by way of example and is not intended to be exhausted or exclusive:

1. The inclusion of one or more future mining WLAs is not intended to exclude the issuance of future nonmining NPDES permits in this watershed or any waters of the Commonwealth.

2. The inclusion of one or more future mining WLAs in specific segments of this watershed is not intended to exclude future mining in any segments of this watershed that does not have a future mining WLA.
3. The inclusion of future mining WLAs does not preclude the amending of this AMD TMDL to accommodate additional NPDES permits.

All of the remaining discharges in the watershed are from abandoned mines and will be treated as nonpoint sources. The distinction between nonpoint and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge.

Clean Water Act Requirements

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

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

- States to develop lists (Section 303(d) lists) of impaired waters for which current pollution controls are not stringent enough to meet WQSs (the list is used to determine which streams need TMDLs);

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

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

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

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

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

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

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

Section 303(d) Listing Process

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

The primary method adopted by the Pennsylvania Department of Environmental Protection (PADEP) for evaluating waters changed between the publication of the 1996 and 1998 303(d) lists. Prior to 1998, data used to list streams were in a variety of formats, collected under differing protocols. Information also was gathered through the Section 305(b)[2] reporting process. Since that time, PADEP has been using the Unassessed Waters Protocol (UWP), a modification of the USEPA Rapid Bioassessment Protocol II (RPB-II), as the primary mechanism to assess Pennsylvania's waters. The UWP provides a more consistent approach to assessing Pennsylvania's streams.

The assessment method requires selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. A biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment can vary between sites. All the biological surveys include kick-screen sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates are identified to the family level in the field.

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

Basic Steps for Determining a TMDL

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

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. Collecting and summarizing pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculating the TMDL for the waterbody using USEPA approved methods and computer models;
3. Allocating pollutant loads to various sources;
4. Determining critical and seasonal conditions;
5. Soliciting public review and comment on the draft TMDL;
6. Submitting the final TMDL to USEPA; and
7. Determining approval of the TMDL by USEPA.

Watershed History

Due to the Caledonia Syncline following the main stem of the Bennett Branch for much of its length, the extraction of coal has been extensive in the watershed. Historical data show that mining began in this area in the middle to late nineteenth century. By the early twentieth century, extensive underground mining was initiated with most of those mines closed by the late 1960s. Limited deep mining continues today. Surface mining began in the 1940s and continues to a lesser extent today.

Most coal mining has been completed in the Allegheny Formation, particularly the Middle Kittanning (C), Lower Kittanning (B), and Clarion (A) coal seams. Since most of the underground mines were developed up-dip to allow for the gravity draining of mine water and many surface mines were abandoned and left unreclaimed, the Bennett Branch Watershed suffers from AMD and abandoned mine lands (AML) impacts throughout most of its length.

According to PADEP, the quality of the overburden associated with the Lower Kittanning (C) seam is some of the worst found in the Commonwealth. A majority of the very adverse water quality emanating from the AMD discharges impacting the Bennett Branch Watershed is caused by this very acidic overburden.

According to PADEP, three areas of the watershed contribute a majority of the coal mining impacts. The mining overburden surrounding the towns of Hollywood and Tyler in the headwaters of the watershed contributes about 29 percent of the acid loading to the Bennett Branch. The mining overburden surrounding the town of Caledonia contributes 24 percent of the acid load. The largest acid load contribution (34 percent) is located in the Dents Run Subwatershed, particularly the Porcupine Run Subwatershed of Dents Run.

Currently, there are major efforts to correct the impacts from coal mining in the Hollywood and Tyler areas and in the Dents Run Subwatershed through a public/private partnership. This effort is being led by the U.S. Army Corp of Engineers (USACE), the PADEP Bureau of Abandoned Mine Reclamation (BAMR), and the Bennett Branch Watershed Association (BBWA) at the grassroots level.

Many AML reclamation projects and passive and active mine drainage treatment systems have been completed in the Dents Run Subwatershed with more to come in the near future. In addition, a large active treatment plant is slated for construction in the Hollywood and Tyler area of the watershed that will collect and gravity feed 27 discharges to one centralized active treatment system that will discharge, on average, 7.2 million gallons per day (MGD) with average acidity, iron (Fe), manganese (Mn), and aluminum (Al) concentrations of 171 milligrams per liter (mg/l), 33.6 mg/l, 2.8 mg/l, and 4.5 mg/l, respectively.

As of July 2008, over $37 million dollars have been dedicated to AMD and AML restoration projects in the Bennett Branch Watershed.

AMD Methodology

A two-step approach was 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 WQSs. 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 are computed based on average annual flow.

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

[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.

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 hot 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 be a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

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

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of applicable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for 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) with WLAs for permitted discharges. 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 0.3	30-Day Average Total Recoverable Dissolved
Manganese (Mn)	1.00	Total Recoverable
pH *	6.0-9.0	N/A

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

TMDL Elements (WLA, LA, MOS)

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

Allocations Summary

These TMDLs will focus remediation efforts on the identified numerical reduction targets for each watershed. The reduction schemes in Table 3 for each segment are based on the assumption that all upstream allocations are implemented and take into account all upstream reductions. Attachment D 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 long-term average 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 average flow and a conversion factor at each sample point. The allowable load is the TMDL at that point.

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. Waste load allocations have also been included at some points for future mining operations. The difference between the TMDL and the WLA at each point is the 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 from nonpoint sources 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.

Table 3. Bennett Branch Watershed Summary Table

Parameter	***Existing Load (lbs/day)***	***TMDL Allowable Load (lbs/day)***	***WLA (lbs/day)***	***LA (lbs/day)***	***NPS Load Reduction (lbs/day)***	***NPS % Reduction***
BBSC6 – Upstream of South Branch Bennett Branch Confluence (Winterburn, PA)						
Aluminum (lbs/day)	13.86	13.86	*0.56*	13.30	0.00	0.0%
Iron (lbs/day)	21.49	21.49	*2.26*	19.23	0.00	0.0%
Manganese (lbs/day)	2.00	2.00	*1.50*	0.50	0.00	0.0%
Acidity (lbs/day)	25.86	25.86	NA	25.86	0.00	0.0%
BBSC5 – Downstream of Bark Camp Run						
Aluminum (lbs/day)	87.92	87.92	*1.68*	86.24	0.00	0.0%*
Iron (lbs/day)	76.95	76.95	*6.78*	70.17	0.00	0.0%*
Manganese (lbs/day)	31.09	31.09	*4.50*	26.59	0.00	0.0%*
Acidity (lbs/day)	3,207.48	1,732.04	NA	1,732.04	1,475.44	46.0%*
BBSC4 – Downstream of Moose Run (Penfield, PA)						
Aluminum (lbs/day)	132.36	132.36	*1.68*	130.68	0.00	0.0%*
Iron (lbs/day)	204.54	204.54	*6.78*	197.76	0.00	0.0%*
Manganese (lbs/day)	85.42	85.42	*4.50*	80.92	0.00	0.0%*
Acidity (lbs/day)	8,947.61	2,326.38	NA	2,326.38	5,145.79	68.9%*
BBSC3 – Downstream of Cherry Run (Force, PA)						
Aluminum (lbs/day)	1,045.70	303.25	*1.68*	301.57	742.35	71.0%*
Iron (lbs/day)	1,674.67	636.37	*6.78*	629.59	1,038.30	62.0%*
Manganese (lbs/day)	334.16	334.16	*4.50*	329.66	0.00	0.0%*
Acidity (lbs/day)	22,208.12	1,776.65	NA	1,776.65	13,810.24	88.6%*
BBSC2 – Downstream of Caledonia Run (Caledonia, PA)						
Aluminum (lbs/day)	617.48	277.86	1.82	276.04	0.00	0.0%*
Iron (lbs/day)	732.24	373.44	6.85	366.59	0.00	0.0%*
Manganese (lbs/day)	249.31	249.31	4.53	244.78	0.00	0.0%*
Acidity (lbs/day)	39,033.47	1,561.34	NA	1,561.34	17,040.66	91.6%*
BBSC1 – Mouth of Bennett Branch (Driftwood, PA)						
Aluminum (lbs/day)	972.18	972.18	49.58	922.60	0.00	0.0%*
Iron (lbs/day)	752.47	752.47	112.98	639.49	0.00	0.0%*
Manganese (lbs/day)	748.58	748.58	77.50	671.08	0.00	0.0%*
Acidity (lbs/day)	68,700.61	3,435.03	618.50	2,816.53	27,793.45	89.0%*

NA = not applicable
* Takes into account load reductions from upstream sources.
Numbers in italics are set aside for only future mining operations.

In the instance that the allowable load is equal to the existing load (e.g., iron parameter BBSC6, Table 3), 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.

Waste Load Allocation – Jay Township Water Authority

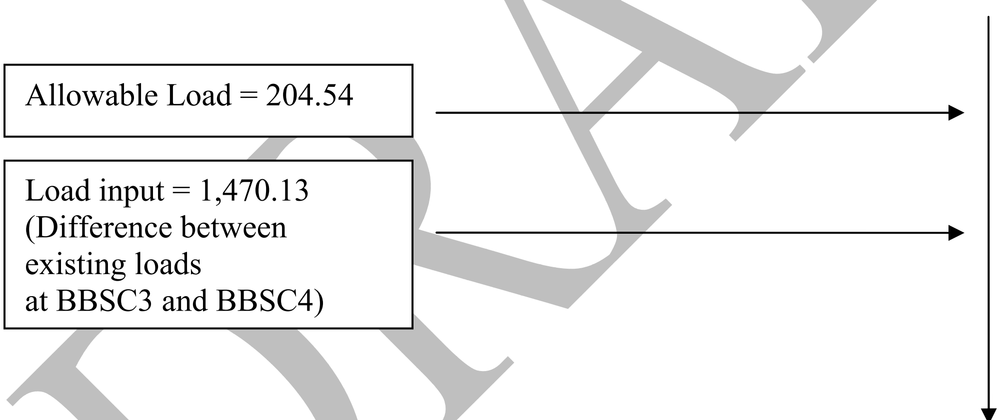
The Jay Township Water Authority (NPDES PA0222500) has one discharge requiring treatment, located downstream of BBSC3. Outfall 001 is a discharge from a pond that receives water treatment plant filter backwash. The following table shows the WLA for this discharge.

Table 4. Waste Load Allocations at Jay Township Water Authority Operation

Parameter Outfall 001	Monthly Average Conc. (mg/L)	Design Flow (MGD)	Allowable Load (lbs/day)
Fe	2.0	0.0041	0.07
Mn	1.0	0.0041	0.03
Al	4.0	0.0041	0.14

The following is an example of how the allocations in Table 3 for a stream segment are calculated. For this example, iron allocations for BBSC3 of Bennett Branch are shown. As demonstrated in the example, all upstream contributing loads are accounted for at each point. Attachment D contains the TMDLs by segment analysis for each allocation point in a detailed discussion. These analyses follow the example below. Attachment A contains maps of the sampling point locations for reference.

Allocations for BBSC4	
	Fe (lbs/day)
Existing load at BBSC4	204.54
Allowable load at BBSC4	204.54



Allocations at BBSC3	
	Fe (lbs/day)
Existing load at BBSC3	1,674.67
Difference of measured loads between loads that enter and existing BBSC3	1,470.13
Percent loss due calculated at BBSC3	0.0%
Additional loads tracked from above samples	204.54
Percent of upstream loads that reach BBSC3	100.0%
Total load tracked between BBSC4 and BBSC3	1,674.67
Allowable load at BBSC3	636.37
Load reduction at BBSC3	1,038.30
Percent reduction required at BBSC3	62.0%

Allowable load= 636.37 lbs/day

The allowable iron load tracked from BBSC4 is 204.54 lbs/day. The existing load at BBSC4 was subtracted from the existing load at BBSC3 to show the actual measured increase of iron load that has entered the stream between these upstream sites and BBSC3 (1,470.13 lbs/day). This increased value was then added to the calculated allowable load from BBSC4 to calculate the total load that was tracked between BBSC4 and BBSC3 (allowable loads @ BBSC4 + the difference in existing load between BBSC4 and BBSC3). This total load tracked was then subtracted from the calculated allowable load at BBSC3 to determine the amount of load to be reduced at BBSC3. This total load was found to be 1,674.67 lbs/day; it was 1,038.30 lbs/day greater then the allowable load at BBSC3 of 636.37 lbs/day. Therefore, a 62 percent iron reduction at BBSC3 is necessary.

Recommendations

As mentioned, there has been an extremely successful partnership in place combining the efforts of USACE, the Commonwealth of Pennsylvania (PADEP and the Pennsylvania Game Commission (PGC)), and various grassroots organizations (BBWA). All told, as of February 2008, $37,505,324 has been allocated to planning, design, and construction of AML reclamation and AMD treatment projects to restore the Bennett Branch from the impairments of mining.

Most of the restoration activities have been in the two highest priority areas in terms of acidity loading. The Hollywood/Tyler area of the watershed contributes 29 percent of the acidity loading to Bennett Branch. The Hollywood/Tyler Active Treatment Plant, which will collect and treat 27 distinct discharge points in this area, is nearing the construction phase. In addition, many AML reclamation and AMD treatment projects have been completed and are planned in the Dents Run Subwatershed of Bennett Branch, mainly focusing in the Porcupine Run section. In summer 2008, due mainly to two lime dosers that were installed on Discharge 17 impacting Porcupine Run, the largest AMD loading discharge in the Dents Run Subwatershed, Dents Run, contained a net alkaline concentration upon entering the Bennett Branch on occasion. The mouth of Dents Run has probably not been net alkaline for more than 100 years.

After the construction of the Hollywood/Tyler Active Treatment Plant and the restoration of Dents Run, the Bennett Branch partnership will begin to focus attention on the mining impacts surrounding the town of Caledonia, the final priority area in terms of acidity loading. This area contributes 24 percent of the acidity loading entering the Bennett Branch. Once all three of these areas are restored, approximately 87 percent of the acidity loading entering the Bennett Branch will be eliminated.

Another pollution impact that should be investigated following the restoration of the Hollywood/Tyler, Dents Run, and Caledonia areas is the acid depositional impacts to the watersheds not plagued by the ramifications of mining. The Bennett Branch contains many streams such as Medix Run, Hicks Run, and Mix Run that are not impacted by mining. However, these streams contain non-buffering geology which leads to higher acidity concentrations during times of precipitation, especially during the spring melt. Consequently, these streams are more infertile than they should be because the acid deposition cannot be buffered enough before entering the waterway. In these cases, a strategically placed limestone silo, off-channel limestone pod, or limestone sanding could improve water quality drastically. Consequently, this would improve the aquatic ecology of the stream, particularly benefiting the native brook trout populations found in the Bennett Branch Watershed.

Various methods to eliminate or treat pollutant sources and to provide a reasonable assurance that the proposed TMDLs can be met exist in Pennsylvania. These methods include PADEP's primary efforts to improve water quality through reclamation of abandoned mine lands (for abandoned mining) and through the National Pollution Discharge Elimination System (NPDES) permit program (for active mining). Funding sources available that are currently being used for projects designed to achieve TMDL reductions include the USEPA's 319 grant program and Pennsylvania's Growing Greener Program. Federal funding is through the Department of the Interior, Office of Surface Mining (OSM), for reclamation and mine drainage treatment through the Appalachian Clean Streams Initiative and through Watershed Cooperative Agreements.

OSM reports that of the $8.5 billion of the nation's high priority (defined as Priority 1 & 2 features or those that threaten public health and safety) coal-related AML problems in the AML inventory, $6.6 billion (78 percent) have yet to be reclaimed; $3.6 billion of this total is attributable to Pennsylvania watershed costs. Almost 83 percent of the $2.3 billion of coal-related environmental problems (Priority 3) in the AML inventory are not reclaimed.

The Bureau of Abandoned Mine Reclamation, Pennsylvania's primary bureau in dealing with abandoned mine reclamation (AMR) issues, has established a comprehensive plan for abandoned mine reclamation throughout the Commonwealth to prioritize and guide reclamation efforts for throughout the state to make the best use of valuable funds (www.dep.state.pa.us/dep/deputate/minres/bamr/complan1.htm). In developing and implementing a comprehensive plan for abandoned mine reclamation, the resources (both human and financial) of the participants must be coordinated to insure cost-effective results. The following set of principles is intended to guide this decision making process:

- Partnerships between the PADEP, watershed associations, local governments, environmental groups, other state agencies, federal agencies, and other groups organized to reclaim abandoned mine lands are essential to achieving reclamation and abating acid mine drainage in an efficient and effective manner.

- Partnerships between AML interests and active mine operators are important and essential in reclaiming abandoned mine lands.

- Preferential consideration for the development of AML reclamation or AMD abatement projects will be given to watersheds or areas for which there is an approved rehabilitation plan (guidance is given in Attachment G).

- Preferential consideration for the use of designated reclamation moneys will be given to projects that have obtained other sources or means to partially fund the project or to projects that need the funds to match other sources of funds.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects where there are institutional arrangements for any necessary long-term operation and maintenance costs.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects that have the greatest worth.

- Preferential consideration for the development of AML projects will be given to AML problems that impact people over those that impact property.

- No plan is an absolute; occasional deviations are to be expected.

A detailed decision framework is included in the plan that outlines the basis for judging projects for funding, giving high priority to those projects whose cost/benefit ratios are most favorable and those in which stakeholder and landowner involvement is high and secure.

In addition to the abandoned mine reclamation program, regulatory programs also are assisting in the reclamation and restoration of Pennsylvania's land and water. PADEP has been effective in implementing the NPDES program for mining operations throughout the Commonwealth. This reclamation was done through the use of remining permits that have the potential for reclaiming abandoned mine lands, at no cost to the Commonwealth or the federal government. Long-term treatment agreements were initialized for facilities/operators that need to assure treatment of post-mining discharges or discharges they degraded. These agreements will provide for long-term treatment of discharges. According to OSM, "PADEP is conducting a program where active mining sites are, with very few exceptions, in compliance with the approved regulatory program."

The Commonwealth is exploring all options to address its abandoned mine problem. During 2000-2006, many new approaches to mine reclamation and mine drainage remediation have been explored and projects funded to address problems in innovative ways. These include:

- Project XL – PADEP has proposed this XL Project to explore a new approach to encourage the remining and reclamation of abandoned coal mine sites. The approach would be based on compliance with instream pollutant concentration limits and implementation of best management practices (BMPs), instead of NPDES numeric effluent limitations measured at individual discharge points. This XL project would provide for a test of this approach in up to eight watersheds with significant AMD pollution. The project will collect data to compare instream pollutant concentrations versus the loading from individual discharge points and provide for the evaluation of the performance of BMPs and this alternate strategy in PADEP's efforts to address AMD.

- Awards of grants for: (1) proposals with economic development or industrial application as their primary goal and which rely on recycled mine water and/or a site that has been made suitable for the location of a facility through the elimination of existing Priority 1 or 2 hazards; and (2) new and innovative mine drainage treatment technologies that will provide waters of higher purity that may be needed by a particular industry at costs below conventional treatment costs as in common use today, or reduce the costs of water treatment below those of conventional lime treatment plants. Eight contracts totaling $4.075 M were awarded in 2006 under this program.

- Projects using water from mine pools in an innovative fashion, such as the Shannopin Deep Mine Pool (in southwestern Pennsylvania), the Barnes & Tucker Deep Mine Pool (the Susquehanna River Basin into the Upper West Branch Susquehanna River), and the Wadesville Deep Mine Pool (Exelon Generation in Schuylkill County).

The BBWA is a very active group in the watershed. In 1993, the Elk County Conservation District submitted a request to BAMR to restore the water quality in the Dents Run Subwatershed. Upon that request, BAMR began monitoring discharges and stream quality to ultimately initiate the restoration of the watershed, combining efforts with various partners, including the BBWA. BAMR has even funded a pass-through grant for just over $3 million to the BBWA to purchase limestone needed for alkaline addition at the numerous reclamation project sites with Dents Run, which includes the construction of a large alkaline trench at the Seep 17 Discharge, the largest AMD loading discharge impacting Dents Run.

Candidate or federally-listed threatened and endangered species may occur in or near the watershed. While implementation of the TMDL should result in improvements to water quality, they could inadvertently destroy habitat for candidate or federally-listed species. TMDL implementation projects should be screened through the Pennsylvania Natural Diversity Inventory (PNDI) early in their planning process, in accordance with the Department's policy titled Policy for Pennsylvania Natural Diversity Inventory (PNDI) Coordination During Permit Review and Evaluation (Document ID# 400-0200-001).

Public Participation

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* on September 20, 2008, and in *The Progress* on September ##, 2008, to foster public comment on the allowable loads calculated. A public meeting was held on October 16, 2008, at St. Joseph Church Parish Hall in Force, Pennsylvania, to discuss the proposed TMDL.

Future TMDL Modifications

In the future, PADEP may adjust the LA and/or WLA in this TMDL to account for new information or circumstances that are developed or discovered during the implementation of the TMDL when a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment between the LA and WLA will only be made following an opportunity for public participation. A WLA adjustment will be made consistent and simultaneous with associated permit(s) revision(s)/reissuances (i.e., permits for revision/reissuance in association with a TMDL revision will be made available for public comment concurrent with the related TMDLs availability for public comment). New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information, and land use information. All changes in the TMDL will be tallied, and once the total changes exceed 1 percent of the total original TMDL allowable load, the TMDL will be revised. The adjusted TMDL, including its LAs and WLAs, will be set at a level necessary to implement the applicable WQS and any adjustment increasing a WLA will be supported by reasonable assurance demonstration that load allocations will be met. PADEP will notify USEPA of any adjustments to the TMDL within 30 days of its adoption and will maintain current tracking mechanisms that contain accurate loading information for TMDL waters.

Changes in TMDLs That May Require USEPA Approval

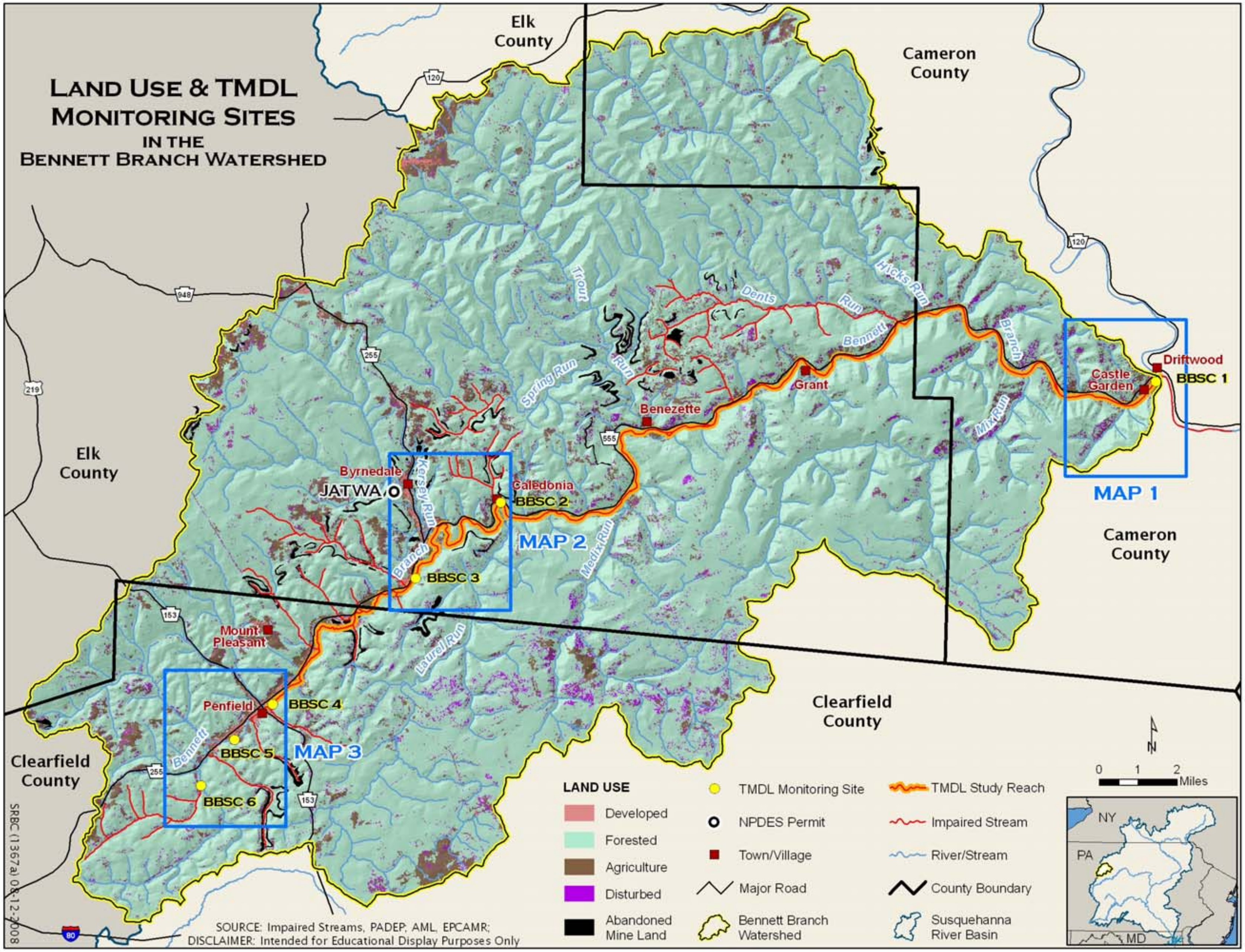
- Increase in total load capacity.
- Transfer of load between point (WLA) and nonpoint (LA) sources.
- Modification of the margin of safety (MOS).
- Change in water quality standards (WQS).
- Non-attainment of WQS with implementation of the TMDL.
- Allocations in trading programs.

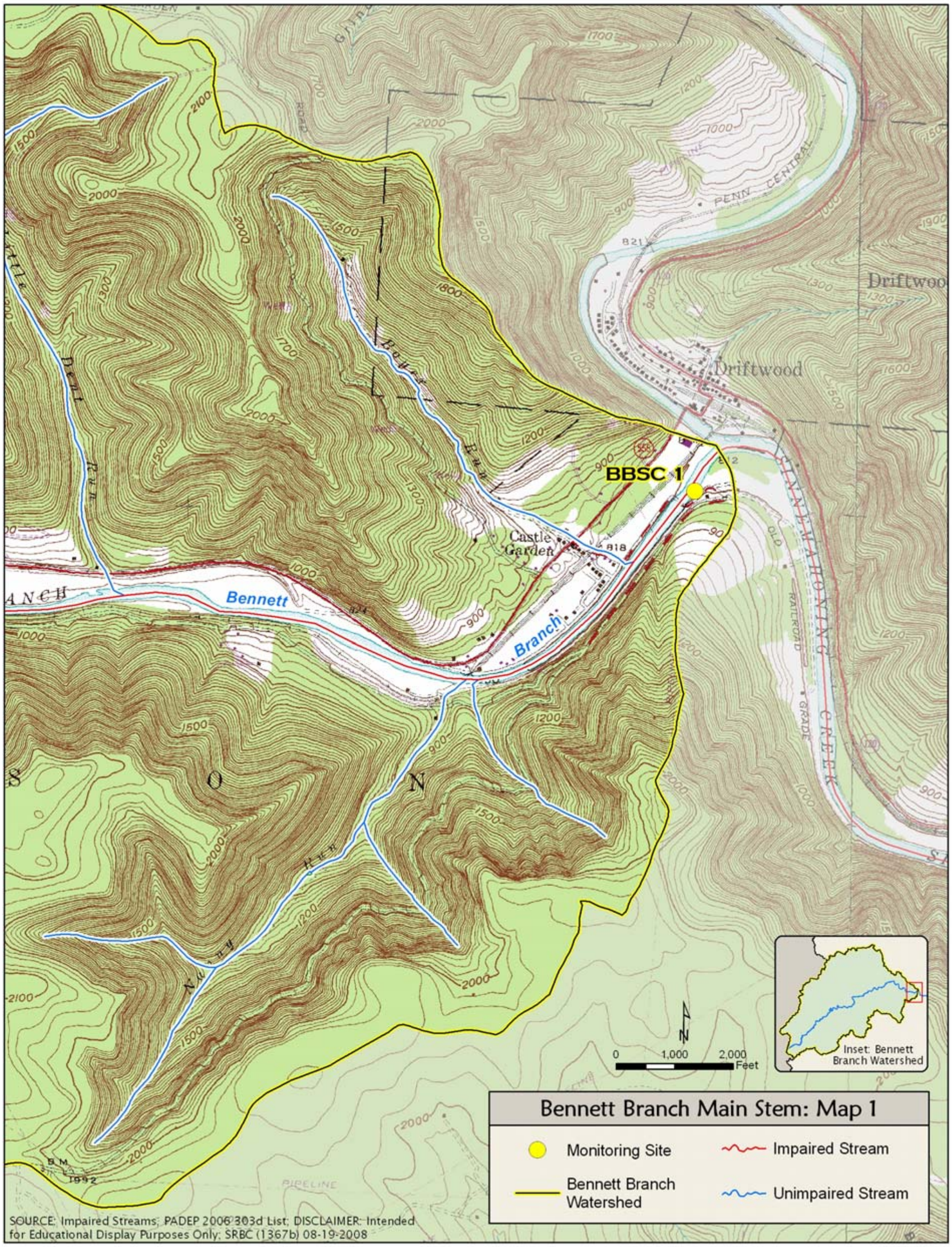
Changes in TMDLs That May Not Require USEPA Approval

- Total loading shift less than or equal to 1% of the total load.
- Increase of WLA results in greater LA reductions provided reasonable assurance of implementation is demonstrated (a compliance/implementation plan and schedule).
- Changes among WLAs with no other changes; TMDL public notice concurrent with permit public notice.
- Removal of a pollutant source that will not be reallocated.
- Reallocation between LAs.
- Changes in land use.

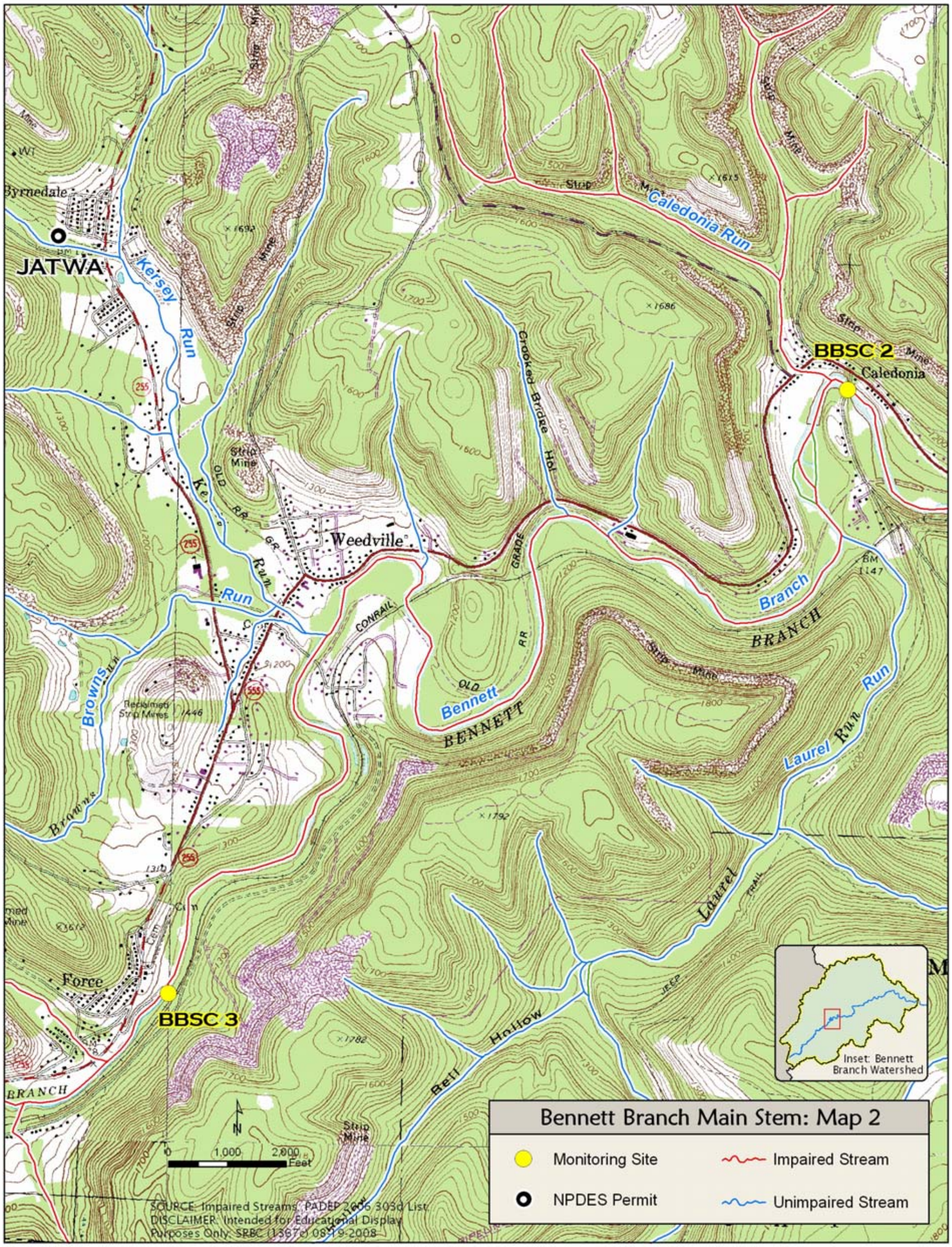
Attachment A

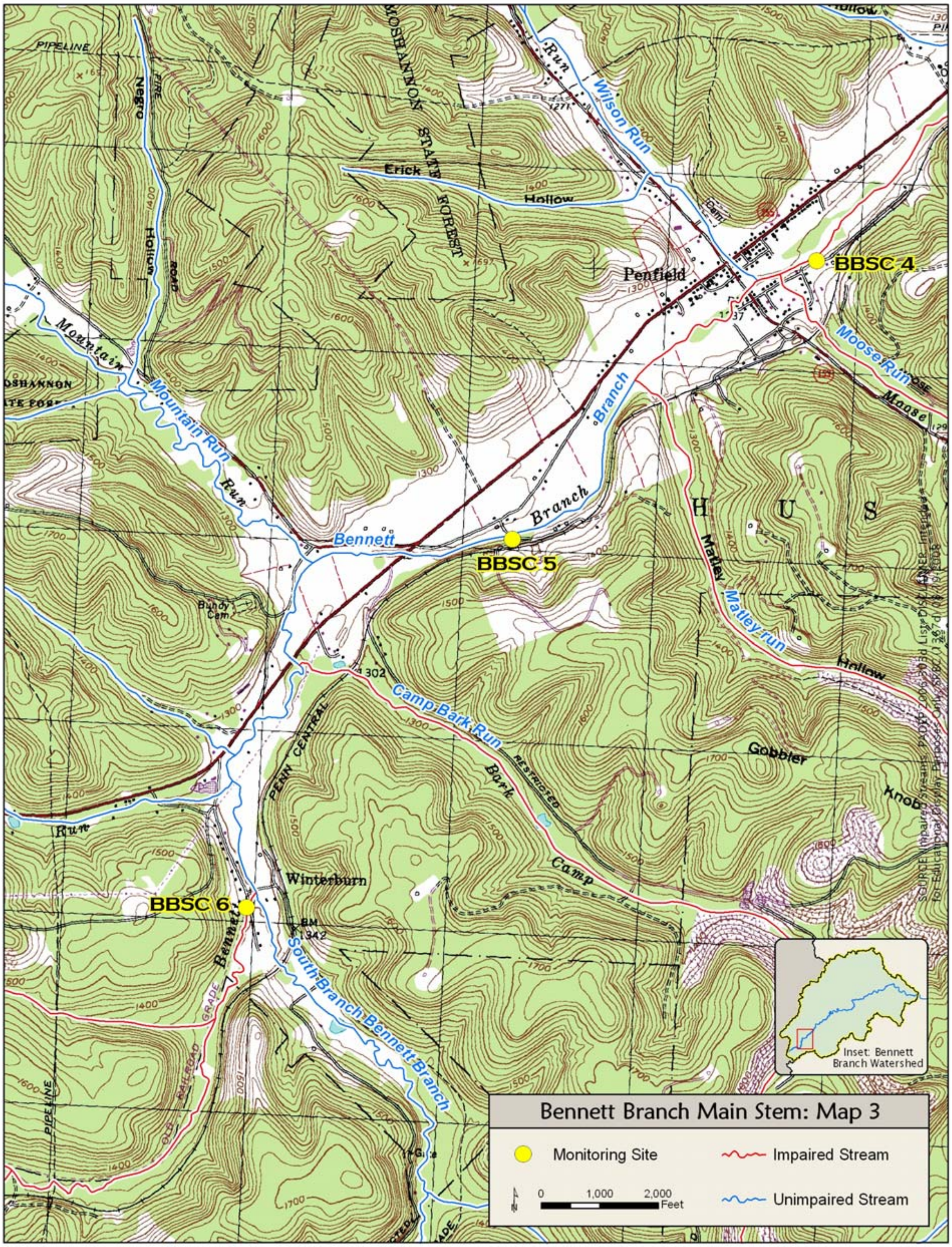
Bennett Branch Sinnemahoning Creek
Watershed Maps


LAND USE & TMDL MONITORING SITES IN THE BENNETT BRANCH WATERSHED
Elk County
Cameron County
Elk County
Cameron County
Clearfield County
Clearfield County
MAP 1
MAP 2
MAP 3
Driftwood
Castle Garden
BBSC 1
Grant
Benezette
Byrnedale
JATWA
Caledonia
BBSC 2
BBSC 3
Mount Pleasant
Penfield
BBSC 4
BBSC 5
BBSC 6
Trout Run
Dents Run
Hicks Run
Bennett Branch
Spring Run
Kersey Run
Medix Run
Mix Run
Laurel Run
120
948
255
219
555
153
80
LAND USE
Developed
Forested
Agriculture
Disturbed
Abandoned Mine Land
TMDL Monitoring Site
NPDES Permit
Town/Village
Major Road
Bennett Branch Watershed
TMDL Study Reach
Impaired Stream
River/Stream
County Boundary
Susquehanna River Basin
0 1 2 Miles
N
NY
PA
MD
SOURCE: Impaired Streams, PADEP; AML, EPCAMR;
DISCLAIMER: Intended for Educational Display Purposes Only
SRBC (1367a) 08-12-2008



Bennett Branch Main Stem: Map 1
Monitoring Site
Impaired Stream
Bennett Branch Watershed
Unimpaired Stream
BBSC 1
Bennett
Branch
Driftwood
Castle Garden
Inset: Bennett Branch Watershed
0 1,000 2,000 Feet
SOURCE: Impaired Streams; PADEP 2006 303d List; DISCLAIMER: Intended for Educational Display Purposes Only; SRBC (1367b) 08-19-2008


Bennett Branch Main Stem: Map 2
Monitoring Site
Impaired Stream
NPDES Permit
Unimpaired Stream
BBSC 2
BBSC 3
JATWA
Byrnedale
Caledonia
Weedville
Force
Caledonia Run
Kersey Run
Crooked Bridge Hol
Bennett Branch
Laurel Run
Browns Run
Bell Hollow
Inset: Bennett Branch Watershed
SOURCE: Impaired Streams: PADEP 2006 303d List
DISCLAIMER: Intended for Educational Display Purposes Only. SRBC (1367) 08-19-2008
0 1,000 2,000 Feet



Bennett Branch Main Stem: Map 3
Monitoring Site
Impaired Stream
Unimpaired Stream
0 1,000 2,000 Feet
Inset: Bennett Branch Watershed
BBSC 4
BBSC 5
BBSC 6
Penfield
Winterburn
Wilson Run
Moose Run
Matley run
Camp Bark Run
Mountain Run
South Branch Bennett Branch
Bennett
Branch

Attachment B

Method for Addressing 303(d) Listings for pH

There has been a great deal of research conducted on the relationship between alkalinity, acidity, and pH. Research published by the PADEP 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.*

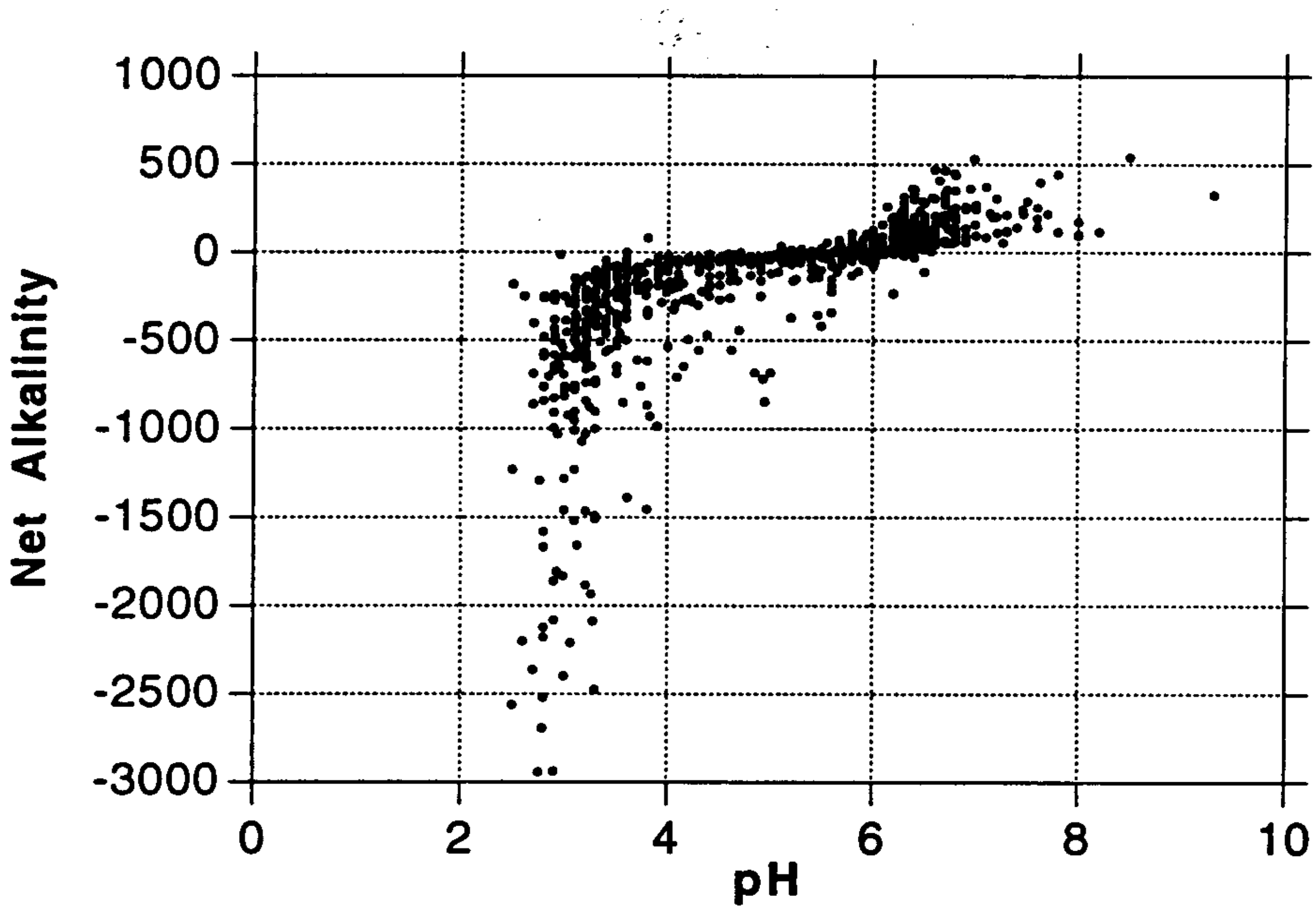


Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania

Attachment C

Method for Calculating Loads from Mine Drainage Treatment Facilities from Surface Mines

Method to Quantify Treatment Pond Pollutant Load

Calculating Waste Load Allocations (WLA) for Active Mining in the TMDL Stream Segment.

The end product of the TMDL report is to develop WLA and Load Allocations (LA) that represent the amount of pollution the stream can assimilate while still achieving instream limits. The LA is the load from abandoned mine lands where there is no NPDES permit or responsible party. The WLA is the pollution load from active mining that is permitted through NPDES.

In preparing the TMDL, calculations are done to determine the allowable load. The actual load measured in the stream is equal to the allowable load plus the reduced load.

Total Measured Load = Allowed Load + Reduced Load

If there is active mining or anticipated mining in the near future in the watershed, the allowed load must include both a WLA and a LA component.

Allowed Load (lbs/day) = WLA (lbs/day) + LA (lbs/day)

The following is an explanation of the quantification of the potential pollution load reporting to the stream from permitted pit water treatment ponds that discharge water at established effluent limits.

Surface coal mines remove soil and overburden materials to expose the underground coal seams for removal. After removal of the coal, the overburden is replaced as mine spoil and the soil is replaced for revegetation. In a typical surface mining operation, the overburden material is removed and placed in the previous cut where the coal has been removed. In this fashion, an active mining operation has a pit that progresses through the mining site during the life of the mine. The pit may have water reporting to it, as it is a low spot in the local area. Pit water can be the result of limited shallow groundwater seepage, direct precipitation into the pit, and surface runoff from partially regarded areas that have been backfilled but not yet revegetated. Pit water is pumped to nearby treatment ponds where it is treated to the required treatment pond effluent limits. The standard effluent limits are as follows, although stricter effluent limits may be applied to a mining permit's effluent limits to insure that the discharge of treated water does not cause instream limits to be exceeded.

Standard Treatment Pond Effluent Limits:
Alkalinity > Acidity
6.0 <= pH <= 9.0
Fe < 3.0 mg/l
Mn < 2.0 mg/l

Discharge from treatment ponds on a mine site is intermittent and often varies as a result of precipitation events. Measured flow rates are almost never available. If accurate flow data are available, they can be used to quantify the WLA. The following is an approach that can be used to determine a WLA for an active mining operation when treatment pond flow rates are not available. The methodology involves quantifying the hydrology of the portion of a surface mine site that contributes flow to the pit and then calculating WLA using NPDES treatment pond effluent limits.

The total water volume reporting to ponds for treatment can come from two primary sources: direct precipitation to the pit and runoff from the unregraded area following the pit's progression through the site. Groundwater seepage reporting to the pit is considered negligible compared to the flow rates resulting from precipitation.

In an active mining scenario, a mine operator pumps pit water to the ponds for chemical treatment. Pit water is often acidic with dissolved metals in nature. At the treatment ponds, alkaline chemicals are added to increase the pH and encourage dissolved metals to precipitate and settle. Pennsylvania averages 41.4 inches of precipitation per year (Mid-Atlantic River Forecast Center, National Weather Service, State College, PA, 1961-1990, http://www.dep.state.pa.us/dep/subject/hotopics/drought/PrecipNorm.htm). A maximum pit dimension without special permit approval is 1500 feet long by 300 feet wide. Assuming that 5 percent of the precipitation evaporates and the remaining 95 percent flows to the low spot in the active pit to be pumped to the treatment ponds, results in the following equation and average flow rates for the pit area.

41.4 in. precip./yr x 0.95 x 1 ft./12/in. x 1500'x300'/pit x 7.48 gal/ft^3 x 1yr/365days x 1day/24hr. x 1hr./60 min. =

= 21.0 gal/min average discharge from direct precipitation into the open mining pit area.

Pit water can also result from runoff from the unregraded and revegetated area following the pit. In the case of roughly backfilled and highly porous spoil, there is very little surface runoff. It is estimated that 80 percent of precipitation on the roughly regarded mine spoil infiltrates, 5 percent evaporates, and 15 percent may run off to the pit for pumping and potential treatment (Jay Hawkins, Office of Surface Mining, Department of the Interior, Personal Communications 2003). Regrading and revegetation of the mine spoil is conducted as the mining progresses. PADEP encourages concurrent backfilling and revegetation through its compliance efforts and it is in the interest of the mining operator to minimize the company's reclamation bond liability by keeping the site reclaimed and revegetated. Experience has shown that reclamation and revegetation is accomplished two to three pit widths behind the active mining pit area. PADEP uses three pit widths as an area representing potential flow to the pit when reviewing the NPDES permit application and calculating effluent limits based on best available treatment technology and insuring that instream limits are met. The same approach is used in the following equation, which represents the average flow reporting to the pit from the unregraded and unrevegetated spoil area.

41.4 in. precip./yr x 3 pit areas x 1 ft./12/in. x 1500'x300'/pit x 7.48 gal/ft^3 x 1yr/365days x 1day/24hr. x 1hr./60 min. x 15 in. runoff/100 in. precipitation =

= 9.9 gal./min. average discharge from spoil runoff into the pit area.

The total average flow to the pit is represented by the sum of the direct pit precipitation and the water flowing to the pit from the spoil area as follows:

$$\text{Total Average Flow} = \text{Direct Pit Precipitation} + \text{Spoil Runoff}$$

$$\text{Total Average Flow} = 21.0\text{ gal./min} + 9.9\text{ gal./min.} = 30.9\text{ gal./min.}$$

The resulting average waste load from a permitted treatment pond area is as follows.

Allowable Iron Waste Load Allocation:

$$30.9\text{ gal./min.} \times 3\text{ mg/l} \times 0.01202 = 1.1\text{ lbs./day}$$

Allowable Manganese Waste Load Allocation:

$$30.9\text{ gal./min.} \times 2\text{ mg/l} \times 0.01202 = 0.7\text{ lbs./day}$$

Allowable Aluminum Waste Load Allocation:

$$30.9\text{ gal./min.} \times 0.75\text{ mg/l} \times 0.01202 = 0.3\text{ lbs./day}$$

(Note: 0.01202 is a conversion factor to convert from a flow rate in gal/min. and a concentration in mg/l to a load in units of lbs/day.)

There is little or no documentation available to quantify the actual amount of water that is typically pumped from active pits to treatment ponds. Experience and observations suggest that the above approach is very conservative and overestimates the quantity of water, creating a large margin of safety in the methodology. County specific precipitation rates can be used in place of the long-term state average rate, although the margin of safety is greater than differences from individual counties. It is common for many mining sites to have very “dry” pits that rarely accumulate water that would require pumping and treatment.

Also, it is the goal of PADEP’s permit review process to not issue mining permits that would cause negative impacts to the environment. As a step to insure that a mine site does not produce acid mine drainage, it is common to require the addition of alkaline materials (waste lime, baghouse lime, limestone, etc.) to the backfill spoil materials to neutralize any acid-forming materials that may be present. This practice of ‘alkaline addition’ or the incorporation of naturally occurring alkaline spoil materials (limestone, alkaline shale, or other rocks) may produce alkaline pit water with very low metals concentrations that does not require treatment. A comprehensive study in 1999 evaluated mining permits issued since 1987 and found that only 2.2 percent resulted in a post-mining pollution discharge (Evaluation of Mining Permits Resulting in Acid Mine Drainage 1987-1996: A Post Mortem Study, March 1999). As a result of efforts to insure that acid mine drainage is prevented, most mining operations have alkaline pit water that often meets effluent limits and requires little or no treatment.

While most mining operations are permitted and allowed to have a standard 1500’ x 300’ pit, most are well below that size and have a corresponding decreased flow and load. Where pit dimensions are greater than the standard size or multiple pits are present, the calculations to define the potential pollution load can be adjusted accordingly. Hence, the above calculated WLA is very generous and likely high compared to actual conditions that are generally encountered. A large margin of safety is included in the WLA calculations.

The allowable load for the stream segment is determined by modeling of flow and water quality data. The allowable load has a potential WLA component if there is active mining or anticipated future mining and a LA. So, the sum of the LA and the WLA is equal to the allowed load. The WLA is determined by the above calculations and the LA is determined by the difference between the allowed load and the WLA.

Allowed Load = Waste Load Allocation + Load Allocation

Or

Load Allocation = Allowed Load – Waste Load Allocation

This is an explanation of the quantification of the potential pollution load reporting to the stream from permitted pit water treatment ponds that discharge water at established effluent limits. This allows for including active mining activities and their associated Waste Load in the TMDL calculations to more accurately represent the watershed pollution sources and the reductions necessary to achieve instream limits. When a mining operation is concluded its WLA is available for a different operation. Where there are indications that future mining in a watershed may be greater than the current level of mining activity, an additional WLA amount may be included in the allowed load to allow for future mining.

Attachment D

TMDLs By Segment

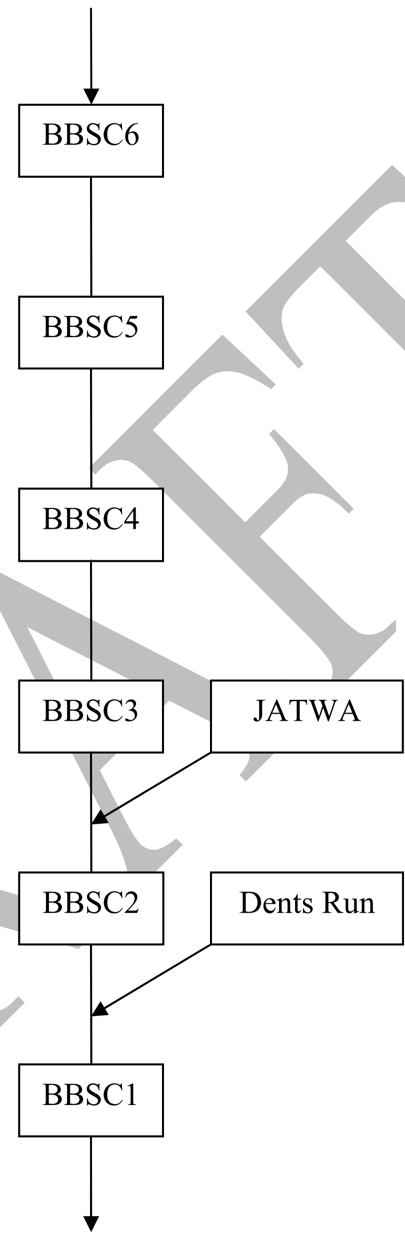
Bennett Branch Sinnemahoning Creek

The TMDL for Bennett Branch consists of load allocations to seven sampling sites on Bennett Branch (BBSC7, BBSC6, BBSC5, BBSC4, BBSC3, BBSC2, and BBSC1). Sample data sets were collected in 2003 and 2004. All sample points are shown on the maps in Attachment A as well as on the loading schematic presented on the following page.

Bennett Branch is listed on the 1996 PA Section 303(d) list for metals from AMD and on the 2002 303(d) list for pH from AMD as being the cause of the degradation to this stream. The method and rationale for addressing pH is contained in Attachment B, with the objective to reduce acid loading to the stream, which will in turn raise the pH to the desired range (pH 6-9) 99 percent of the time.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity is determined at each sample point. These analyses are designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The following is an explanation of the TMDL for each allocation point.

Bennett Branch Sampling Diagram
Arrows represent direction of flow, and diagram is not to scale.



BBSC6: Bennett Branch Upstream of South Branch Bennett Branch Confluence

BBSC6 is located just east of Winterburn, Pa, just upstream of Bennett Branch's confluence with the South Branch Bennett Branch. Samples were collected approximately 100 feet upstream of the Winterburn Road Bridge.

The TMDL for this section of Bennett Branch consists of a load allocation to the watershed area upstream of BBSC6. There are no major AMD influences upstream of BBSC6.

An average instream flow measurement was available for point BBSC6 (6.641 MGD). The load allocations made at point BBSC6 for this stream segment are presented in Table D1.

Table D1. TMDL Calculations at Point BBSC6				
Flow = 6.641 MGD	*Measured Sample Data*		*Allowable*	
Parameter	*Conc. (mg/l)*	*Load (lbs/day)*	*LTA Conc. (mg/l)*	*Load (lbs/day)*
Fe	0.39	21.49	0.39	21.49
Mn	0.04	2.00	0.04	2.00
Al	0.25	13.86	0.25	13.86
Acidity	0.47	25.86	0.47	25.86
Alkalinity	32.33	1,791.91	-	-

ND- Not Detected, NA - Not Applicable

Reductions at point BBSC6 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point BBSC6 are shown in Table D2.

Table D2. Calculation of Load Reduction Necessary at Point BBSC6				
	Fe (lbs/day)	*Mn (lbs/day)*	*Al (lbs/day)*	*Acidity (lbs/day)*
Existing load at BBSC6	21.49	2.00	13.86	25.86
Allowable load at BBSC6	21.49	2.00	13.86	25.86
Load reduction at BBSC6	0.00	0.00	0.00	0.00
Percent reduction required at BBSC6	0.0%	0.0%	0.0%	0.0%

The TMDL for point BBSC6 does not require a load allocation.

A waste allocation for future mining was included for this segment of Bennett Branch, allowing for one operation with two active pits (1500 feet x 300 feet) to be permitted in the future (Table D3).

Table D3. Waste Load Allocation for Future Mining Operation			
Parameter	***Monthly Avg. Allowable Conc. (mg/L)***	***Average Flow (MGD)***	***Allowable Load (lbs/day)***
Future Operation 1			
Al	0.75	0.090	0.56
Fe	3.0	0.090	2.26
Mn	2.0	0.090	1.50

BBSC5: Bennett Branch Downstream of Bark Camp Run

BBSC5 is located between the entries of Bark Camp Run, the first listed AMD impaired tributary to Bennett Branch, and Matley Run, the second. Samples were collected approximately 70 feet downstream of the Munn Road Bridge.

The TMDL for this section of BBSC5 consists of a load allocation to the watershed area between BBSC6 and BBSC5. Addressing the mining impacts above this point addresses the impairment for the stream segment.

An average instream flow measurement was available for point BBSC5 (42.145 MGD). The load allocations made at point BBSC5 for this stream segment are presented in Table D4.

Table D4. TMDL Calculations at Point BBSC5				
Flow = 42.145 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	0.22	76.95	0.22	76.95
Mn	0.09	31.09	0.09	31.09
Al	0.25	87.92	0.25	87.92
Acidity	9.12	3,207.48	4.92	1,732.04
Alkalinity	22.40	7,878.02	-	-

The loading reduction for point BBSC6 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point BBSC5. This value was compared to the allowable load at point BBSC5. Reductions at point BBSC5 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point BBSC5 are shown in Table D5.

Table D5. Calculation of Load Reduction Necessary at Point BBSC5

	Fe (lbs/day)	*Mn (lbs/day)*	*Al (lbs/day)*	*Acidity (lbs/day)*
Existing load at BBSC5	76.95	31.09	87.92	3,207.48
Difference of measured loads between loads that enter and existing BBSC5	55.46	29.09	74.06	3,181.62
Percent loss due calculated at BBSC5	0.0%	0.0%	0.0%	0.0%
Additional loads tracked from above samples	21.49	2.00	13.86	25.86
Percent of upstream loads that reach BBSC5	100.0%	100.0%	100.0%	100.0%
Total load tracked between BBSC6 and BBSC5	76.95	31.09	87.92	3,207.48
Allowable load at BBSC5	76.95	31.09	87.92	1,732.04
Load reduction at BBSC5	0.00	0.00	0.00	1,475.44
Percent reduction required at BBSC5	0.0%	0.0%	0.0%	46.0%

The TMDL for point BBSC5 requires a load allocation for acidity.

A waste allocation for future mining was included for this segment of Bennett Branch, allowing for three operations with two active pits (1500 feet x 300 feet) to be permitted in the future (Table D6).

Table D6. Waste Load Allocation for Future Mining Operations

Parameter	*Monthly Avg. Allowable Conc. (mg/L)*	*Average Flow (MGD)*	*Allowable Load (lbs/day)*
Future Operation 1			
Al	0.75	0.090	0.56
Fe	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 2			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 3			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50

BBSC4: Bennett Branch Downstream of Moose Run

BBSC4 is located near the town of Penfield. BBSC4 was sampled upstream of Denny's Road, downstream of the entry of Moose Run, an AMD impacted tributary to Bennett Branch.

The TMDL for this section of Bennett Branch consists of a load allocation to the watershed area between BBSC5 and BBSC4. Addressing the mining impacts above this point addresses the impairment for the stream segment.

An average instream flow measurement was available for point BBSC4 (63.444 MGD). The load allocations made at point BBSC4 for this stream segment are presented in Table D7.

Table D7. TMDL Calculations at Point BBSC4				
Flow = 63.444 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	0.39	204.54	0.39	204.54
Mn	0.16	85.42	0.16	85.42
Al	0.25	132.36	0.25	132.36
Acidity	16.90	8,947.61	4.39	2,326.38
Alkalinity	18.67	9,882.96	-	-

The loading reduction for point BBSC5 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point BBSC4. This value was compared to the allowable load at point BBSC4. Reductions at point BBSC4 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point BBSC4 are shown in Table D8.

Table D8. Calculation of Load Reduction Necessary at Point BBSC4				
	Fe (lbs/day)	***Mn (lbs/day)***	***Al (lbs/day)***	***Acidity (lbs/day)***
Existing load at BBSC4	204.54	85.42	132.36	8,947.61
Difference of measured loads between loads that enter and existing BBSC4	127.59	54.33	44.44	5,740.13
Percent loss due calculated at BBSC4	0.0%	0.0%	0.0%	0.0%
Additional loads tracked from above samples	76.95	31.09	87.92	1,732.04
Percent of upstream loads that reach BBSC4	100.0%	100.0%	100.0%	100.0%
Total load tracked between BBSC5 and BBSC4	204.54	85.42	132.36	7,472.17
Allowable load at BBSC4	204.54	85.42	132.36	2,326.38
Load reduction at BBSC4	0.00	0.00	0.00	5,145.79
Percent reduction required at BBSC4	0.0%	0.0%	0.0%	68.9%

The TMDL for point BBSC4 requires a load allocation for acidity.

A waste allocation for future mining was included for this segment of Bennett Branch, allowing for three operations with two active pits (1500 feet x 300 feet) to be permitted in the future (Table D9).

Table D9. Waste Load Allocation for Future Mining Operations			
Parameter	***Monthly Avg. Allowable Conc. (mg/L)***	***Average Flow (MGD)***	***Allowable Load (lbs/day)***
Future Operation 1			
Al	0.75	0.090	0.56
Fe	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 2			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 3			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50

BBSC3: Bennett Branch Downstream of Cherry Run

BBSC3 is located near the town of Force. BBSC3 was sampled upstream of the Redwood Avenue Bridge off State Route 555, downstream of the entry of Cherry Run, an AMD impacted tributary to Bennett Branch. BBSC3 is also downstream of the Hollywood and Tyler area discharges (27 in total), where designs are in place for a large active AMD treatment system.

The TMDL for this section of Bennett Branch consists of a load allocation to the watershed area between BBSC4 and BBSC3. Addressing the mining impacts above this point addresses the impairment for the stream segment.

An average instream flow measurement was available for point BBSC3 (93.051 MGD). The load allocations made at point BBSC3 for this stream segment are presented in Table D10.

Table D10. TMDL Calculations at Point BBSC3				
Flow = 93.051 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	2.16	1,674.67	0.82	636.37
Mn	0.43	334.16	0.43	334.16
Al	1.35	1,045.70	0.39	303.25
Acidity	28.60	22,208.12	2.29	1,776.65
Alkalinity	4.33	3,364.87	-	-

The loading reduction for point BBSC4 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point BBSC3. This value was compared to the allowable load at point BBSC3. Reductions at point BBSC3 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point BBSC3 are shown in Table D11.

Table D11. Calculation of Load Reduction Necessary at Point BBSC3				
	Fe (lbs/day)	*Mn (lbs/day)*	*Al (lbs/day)*	*Acidity (lbs/day)*
Existing load at BBSC3	1,674.67	334.16	1,045.70	22,208.12
Difference of measured loads between loads that enter and existing BBSC3	1,470.13	248.74	913.34	13,260.51
Percent loss due calculated at BBSC3	0.0%	0.0%	0.0%	0.0%
Additional loads tracked from above samples	204.54	85.42	132.36	2,326.38
Percent of upstream loads that reach BBSC3	100.0%	100.0%	100.0%	100.0%
Total load tracked between BBSC4 and BBSC3	1,674.67	334.16	1,045.70	15,586.89
Allowable load at BBSC3	636.37	334.16	303.35	1,776.65
Load reduction at BBSC3	1,038.30	0.00	742.35	13,810.24
Percent reduction required at BBSC3	62.0%	0.0%	71.0%	88.6%

The TMDL for point BBSC3 requires a load allocation for total iron, total aluminum, and acidity.

A waste allocation for future mining was included for this segment of Bennett Branch, allowing for three operations with two active pits (1500 feet x 300 feet) to be permitted in the future (Table D12).

Table D12. Waste Load Allocation for Future Mining Operations			
Parameter	*Monthly Avg. Allowable Conc. (mg/L)*	*Average Flow (MGD)*	*Allowable Load (lbs/day)*
Future Operation 1			
Al	0.75	0.090	0.56
Fe	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 2			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 3			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50

JATWA: Jay Township Water Authority

In addition, the Jay Township Water Authority (NPDES Permit No. PA0222500) has one outfall, which receives waste from a water treatment plant filter backwash. This outfall then enters Kersey Run. The outfall discharge does have effluent limits for iron, manganese, and aluminum. The following table shows the waste load allocation for this discharge.

Table D13. Waste Load Allocation for NPDES Permit No. PA0222500			
Parameter			
Outfall 001	**Monthly Average Conc. (mg/L)**	**Design Flow (MGD)**	**Allowable Load (lbs/day)**
Fe	2.0	0.0041	0.07
Mn	1.0	0.0041	0.03
Al	4.0	0.0041	0.14

BBSC2: Bennett Branch Downstream of Caledonia Run

BBSC2 is located near the town of Caledonia. BBSC2 was sampled upstream of the Caledonia Road Bridge off State Route 555, downstream of the entry of Caledonia Run, one of the major AMD impairments to Bennett Branch. After the restoration of the Dents Run Subwatershed and the Hollywood and Tyler area discharges, restoration focus will be placed in the area surrounding Caledonia.

The TMDL for this section of Bennett Branch consists of a load allocation to the watershed area between BBSC3 and BBSC2, including the JATWA permit. Addressing the mining impacts above this point addresses the impairment for the stream segment.

An average instream flow measurement was available for point BBSC2 (122.607 MGD). The load allocations made at point BBSC2 for this stream segment are presented in Table D14.

Table D14. TMDL Calculations at Point BBSC2

Flow = 122.607 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	0.72	732.24	0.36	373.44
Mn	0.24	249.31	0.24	249.31
Al	0.60	617.48	0.27	277.86
Acidity	38.15	39,033.47	1.53	1,561.34
Alkalinity	3.50	3581.05	-	-

The loading reduction for point BBSC3 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point BBSC2. This value was compared to the allowable load at point BBSC2. Reductions at point BBSC2 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point BBSC2 are shown in Table D15.

Table D15. Calculation of Load Reduction Necessary at Point BBSC2

	Fe (lbs/day)	***Mn (lbs/day)***	***Al (lbs/day)***	***Acidity (lbs/day)***
Existing load at BBSC2	732.24	249.31	617.48	39,033.47
Difference of measured loads between loads that enter and existing BBSC2	-942.43	-84.85	-428.22	16,825.35
Percent loss due calculated at BBSC2	56.3%	25.4%	41.0%	0.0%
Additional loads tracked from above samples	636.37	334.16	303.25	1,776.65
Percent of upstream loads that reach BBSC2	43.7%	74.6%	59.0%	100.0%
Total load tracked between BBSC3 and BBSC2	278.09	249.28	178.92	18,602.00
Allowable load at BBSC2	373.44	249.31	277.86	1,561.34
Load reduction at BBSC2	0.00	0.00	0.00	17,040.66
Percent reduction required at BBSC2	0.0%	0.0%	0.0%	91.6%

The TMDL for point BBSC2 requires a load allocation for acidity.

A waste allocation for future mining was included for this segment of Bennett Branch, allowing for three operations with two active pits (1500 feet x 300 feet) to be permitted in the future (Table D16).

Table D16. Waste Load Allocation for Future Mining Operations			
Parameter	***Monthly Avg. Allowable Conc. (mg/L)***	***Average Flow (MGD)***	***Allowable Load (lbs/day)***
Future Operation 1			
Al	0.75	0.090	0.56
Fe	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 2			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 3			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50

DENT 1.0: Dents Run at Mouth

Dents Run enters the Bennett Branch between monitoring points BBSC2 and BBSC1 at the town of Dents Run. Dents Run is highly polluted by AMD and is the largest source of AMD impairment in the Bennett Branch Watershed.

The TMDLs assigned in Tables D17 and D18 are based on the data and calculations found in the Dents Run Watershed TMDL completed by the Susquehanna River Basin Commission and submitted to the USEPA in March 2005.

The TMDL for this section of Dents Run consists of a load allocation from the established Dents Run TMDL. Addressing the mining impacts above this point addresses the impairment for the stream segment. An average instream flow measurement was available for point DENT 1.0 (31.84 MGD). The load allocations made at point DENT 1.0 for this stream segment are presented in Table D17.

Table D17. TMDL Calculations at Point DENT 1.0				
Flow = 31.84 MGD	***Measured Sample Data***		***Allowable***	
Parameter	***Conc. (mg/l)***	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***
Fe	0.40	106.20	0.40	106.20
Mn	2.29	608.10	0.27	73.00
Al	2.58	685.10	0.18	47.90
Acidity	58.24	15,468.00	2.33	618.50
Alkalinity	4.69	1,245.4	-	-

Reductions at point DENT 1.0 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point DENT 1.0 are shown in Table D18.

Table D18. Calculation of Load Reduction Necessary at Point DENT 1.0				
	Fe (lbs/day)	*Mn (lbs/day)*	*Al (lbs/day)*	*Acidity (lbs/day)*
Existing load at DENT 1.0	106.20	608.10	685.10	15,468.00
Allowable load at DENT 1.0	106.20	73.00	47.90	618.50
Percent reduction required at DENT 1.0	0.0%	55.0%	63.0%	0.0%

The TMDL for point DENT 1.0 requires a load allocation for total manganese and aluminum.

BBSC1: Mouth of Bennett Branch

BBSC1 is located near the town of Driftwood, near Bennett Branch's confluence with the Driftwood Branch of Sinnemahoning Creek. The confluence of those two branches form the mainstem of Sinnemahoning Creek. BBSC1 was sampled upstream of the Castle Garden Road Bridge off State Route 555.

The TMDL for this section of Bennett Branch consists of a load allocation to the watershed area between BBSC2 and BBSC1, including the Dents Run TMDL. Addressing the mining impacts above this point addresses the impairment for the stream segment.

An average instream flow measurement was available for point BBSC1 (465.993 MGD). The load allocations made at point BBSC1 for this stream segment are presented in Table D19.

Table D19. TMDL Calculations at Point BBSC1				
Flow = 465.993 MGD	*Measured Sample Data*		*Allowable*	
Parameter	*Conc. (mg/l)*	*Load (lbs/day)*	*LTA Conc. (mg/l)*	*Load (lbs/day)*
Fe	0.19	752.47	0.19	752.47
Mn	0.19	748.58	0.19	748.58
Al	0.25	972.18	0.25	972.18
Acidity	17.67	68,700.61	0.88	3,435.03
Alkalinity	3.67	14,258.62	-	-

The loading reduction for point BBSC2 was used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point BBSC1. This value was compared to the allowable load at point BBSC1. Reductions at point BBSC1 are necessary for any parameter that exceeds the allowable load at this point. Necessary reductions at point BBSC1 are shown in Table D20.

Table D20. Calculation of Load Reduction Necessary at Point BBSC1				
	Fe (lbs/day)	*Mn (lbs/day)*	*Al (lbs/day)*	*Acidity (lbs/day)*
Existing load at BBSC1	752.47	748.58	972.18	68,700.61
Difference of measured loads between loads that enter and existing BBSC1	20.23	499.27	354.70	29,667.14
Percent loss due calculated at BBSC1	0.0%	0.0%	0.0%	0.0%
Additional loads tracked from above samples	373.44	249.31	277.86	1,561.34
Percent of upstream loads that reach BBSC1	100.0%	100.0%	100.0%	100.0%
Total load tracked between BBSC2 and BBSC1	393.67	748.58	632.56	31,228.48
Allowable load at BBSC1	752.47	748.58	972.18	3,435.03
Load reduction at BBSC1	0.00	0.00	0.00	27,793.45
Percent reduction required at BBSC1	0.0%	0.0%	0.0%	89.0%

The TMDL for point BBSC1 requires a load allocation for acidity.

A waste allocation for future mining was included for this segment of Bennett Branch, allowing for three operations with two active pits (1500 feet x 300 feet) to be permitted in the future (Table D21).

Table D21. Waste Load Allocation for Future Mining Operations			
Parameter	*Monthly Avg. Allowable Conc. (mg/L)*	*Average Flow (MGD)*	*Allowable Load (lbs/day)*
Future Operation 1			
Al	0.75	0.090	0.56
Fe	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 2			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50
Future Operation 3			
Fe	0.75	0.090	0.56
Al	3.0	0.090	2.26
Mn	2.0	0.090	1.50

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.

- An additional MOS is provided because that the calculations were done with a daily Fe average instead of the 30-day average.

Seasonal Variation

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

Critical Conditions

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

Attachment E

Excerpts Justifying Changes Between the 1996, 1998, and 2002 Section 303(d) Lists and Integrated Report/List (2004, 2006)

The following are excerpts from the PADEP Section 303(d) narratives that justify changes in listings between the 1996, 1998, and 2002 Section 303(d) Lists and Integrated Report/List (2004, 2006). 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).

<u>Migration to National Hydrography Data (NHD)</u>

New to the 2006 report is use of the 1/24,000 National Hydrography Data (NHD) streams GIS layer. Up until 2006, PADEP relied upon its own internally developed stream layer. Subsequently, the United States Geologic Survey (USGS) developed 1/24,000 NHD streams layer for the Commonwealth based upon national geodatabase standards. In 2005, PADEP contracted with USGS to add missing streams and correct any errors in the NHD. A GIS contractor transferred the old PADEP stream assessment information to the improved NHD and the old PADEP streams layer was archived. Overall, this marked an improvement in the quality of the streams layer and made the stream assessment data compatible with national standards but it necessitated a change in the Integrated Listing format. The NHD is not attributed with the old PADEP five digit stream codes so segments can no longer be listed by stream code but rather only by stream name or a fixed combination of NHD fields known as reachcode and ComID. The NHD is aggregated by Hydrologic Unit Code (HUC) watersheds so HUCs rather than the old State Water Plan (SWP) watersheds are now used to group streams together. The map in

Attachment E illustrates the relationship between the old SWP and new HUC watershed delineations. A more basic change was the shift in data management philosophy from one of "dynamic segmentation" to "fixed segments". The dynamic segmentation records were proving too difficult to mange from an historical tracking perspective. The fixed segment methods will remedy that problem. The stream assessment data management has gone through many changes over the years as system requirements and software changed. It is hoped that with the shift to the NHD and OIT's (Office of Information Technology) fulltime staff to manage and maintain SLIMS the systems and formats will now remain stable over many Integrated Listing cycles.

Attachment F

Water Quality Data Used
In TMDL Calculations

	PARAMETER														
STATION	**Date**	**Time**	**Flow**	**Flow**	**Temp.**	**Cond.**	**D.O.**	**TSS**	**T Fe**	**Alk.**	**T Mn**	**Hot Acidity**	**T Al**	**pH**	**Sulfate**
			cfs	**gpm**	**°C**	**us/cm**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**lab**	**mg/l**
BBSC1	10/21/2003	1010	620.000	278274.600	10.600	105.000	8.080	1.500	0.150	4.000	0.204	18.600	0.250	6.300	38.700
	1/13/2004	1225	818.000	367142.940	1.400	120.000	7.950	9.000	0.411	2.000	0.303	32.200	0.250	5.450	44.800
	4/5/2004	1040	1300.000	583479.000	2.600	85.000	9.290	7.900	0.150	4.000	0.180	33.600	0.250	6.300	42.600
	5/18/2004	850	765.000	343354.950	16.900	91.000	na	1.500	0.150	2.000	0.161	17.000	0.250	6.100	39.200
	6/21/2004	1115	404.000	181327.320	18.400	112.000	7.390	1.500	0.150	6.000	0.154	-1.400	0.250	6.900	45.800
	8/11/2004	1030	419.000	188059.770	19.600	124.000	7.770	8.000	0.150	4.000	0.153	6.000	0.250	6.450	55.800
AVERAGE			**721.000**	**323606.430**	**11.583**	**106.167**	**8.096**	**4.900**	**0.194**	**3.667**	**0.193**	**17.667**	**0.250**	**6.250**	**44.483**
STAND. DEV			**331.204**	**148654.231**	**8.054**	**15.639**	**0.716**	**3.744**	**0.107**	**1.506**	**0.058**	**13.900**	**0.000**	**0.475**	**6.242**
BBSC2	10/21/2003	1215	232.020	104137.537	11.800	140.000	7.550	1.500	0.150	4.000	0.260	38.000	0.572	6.100	49.400
	1/20/2004	1000	na	na	0.000	152.000	7.850	2.750	1.170	2.000	0.301	18.600	0.676	5.200	61.150
	4/5/2004	1125	na	na	3.600	135.000	9.400	12.000	0.899	2.000	0.197	29.800	0.929	4.800	68.300
	5/18/2004	1030	296.380	133024.235	16.100	110.000	8.420	40.000	1.570	3.000	0.197	60.600	0.944	5.700	46.200
	6/23/2004	1255	141.853	63667.882	19.100	124.000	7.460	1.500	0.355	6.000	0.179	40.600	0.250	5.700	65.500
	8/18/2004	820	88.555	39746.141	16.000	193.000	7.770	1.500	0.150	4.000	0.328	41.300	0.250	6.400	79.500
AVERAGE			**189.702**	**85143.949**	**11.100**	**142.333**	**8.075**	**9.875**	**0.716**	**3.500**	**0.244**	**38.150**	**0.604**	**5.650**	**61.675**
STAND. DEV			**92.541**	**41534.968**	**7.655**	**28.640**	**0.731**	**15.318**	**0.590**	**1.517**	**0.062**	**13.942**	**0.309**	**0.582**	**12.383**
BBSC3	10/22/2003	1055	90.120	40448.560	10.100	227.000	6.740	1.500	2.470	4.000	0.449	31.400	1.400	5.850	89.600
	1/20/2004	1120	na	na	0.000	259.000	7.600	1.500	3.130	2.000	0.558	29.200	2.020	4.950	101.600
	4/5/2004	1240	169.570	76108.103	3.900	180.000	8.870	10.000	1.730	4.000	0.276	33.000	1.260	5.500	93.000
	5/25/2004	1650	330.190	148199.178	16.500	173.000	7.160	14.000	1.700	4.000	0.287	32.800	1.010	5.300	71.100
	6/23/2004	1400	87.501	39273.074	18.600	190.000	7.490	12.000	1.570	8.000	0.344	13.400	0.870	3.700	75.000
	8/16/2004	1520	42.474	19063.605	19.000	298.000	7.590	8.000	2.340	4.000	0.668	31.800	1.520	5.550	109.600
AVERAGE			**143.971**	**64618.504**	**11.350**	**221.167**	**7.575**	**7.833**	**2.157**	**4.333**	**0.430**	**28.600**	**1.347**	**5.142**	**89.983**
STAND. DEV			**113.714**	**51038.137**	**8.044**	**49.709**	**0.715**	**5.298**	**0.602**	**1.966**	**0.158**	**7.569**	**0.408**	**0.766**	**14.900**
BBSC4	10/29/2003	900	81.200	36444.996	8.200	180.000	6.460	24.000	0.348	24.000	0.113	0.000	0.250	7.000	43.400
	1/21/2004	1230	na	na	0.000	199.000	7.620	1.500	0.371	20.000	0.165	0.000	0.250	6.500	49.400
	4/5/2004	1345	110.100	49416.183	4.400	174.000	9.860	1.500	0.390	12.000	0.147	33.400	0.250	6.100	74.500
	5/25/2004	1800	226.560	101686.925	16.400	150.000	7.350	8.000	0.347	14.000	0.112	29.000	0.250	6.450	39.600
	6/24/2004	710	52.240	23446.879	14.500	170.000	7.330	1.500	0.462	20.000	0.171	20.400	0.250	6.200	54.250
	8/18/2004	1430	20.717	9298.411	18.500	276.000	7.760	1.500	0.400	22.000	0.260	18.600	0.250	6.800	80.500
AVERAGE			**98.163**	**44058.679**	**10.333**	**191.500**	**7.730**	**6.333**	**0.386**	**18.667**	**0.161**	**16.900**	**0.250**	**6.508**	**56.942**
STAND. DEV			**79.093**	**35499.325**	**7.313**	**44.316**	**1.137**	**9.037**	**0.043**	**4.676**	**0.054**	**14.178**	**0.000**	**0.344**	**16.802**

STATION	Date	Time	Flow	Flow	Temp.	Cond.	D.O.	TSS	T Fe	Alk.	T Mn	Hot Acidity	T Al	pH	Sulfate
			cfs	gpm	°C	us/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	lab	mg/l
BBSC5	10/29/2003	755	59.710	26799.639	7.900	169.000	5.910	7.000	0.150	32.000	0.078	0.000	0.250	7.800	38.250
	4/6/2004	925	65.510	29402.853	5.000	136.000	9.220	4.000	0.150	14.000	0.085	12.400	0.250	6.700	49.500
	5/24/2004	1725	153.440	68868.475	16.100	149.000	7.080	6.000	0.316	12.000	0.104	21.000	0.250	6.700	42.600
	6/24/2004	940	32.550	14609.417	14.500	163.000	7.540	1.500	0.328	22.000	0.081	9.400	0.250	6.800	59.000
	8/18/2004	1000	14.828	6655.251	16.100	253.000	7.430	1.500	0.150	32.000	0.094	2.800	0.250	6.750	87.200
AVERAGE			**65.208**	**29267.127**	**11.920**	**174.000**	**7.436**	**4.000**	**0.219**	**22.400**	**0.088**	**9.120**	**0.250**	**6.950**	**55.310**
STAND. DEV			**53.432**	**23981.863**	**5.139**	**45.978**	**1.188**	**2.525**	**0.094**	**9.529**	**0.011**	**8.293**	**0.000**	**0.477**	**19.474**
BBSC6	10/28/2003	1245	11.266	5056.519	7.300	111.000	6.560	1.500	0.314	36.000	0.025	0.000	0.250	7.300	38.500
	1/14/2004	935	2.676	1201.069	0.100	104.000	6.220	16.000	0.353	24.000	0.025	0.000	0.250	7.000	30.800
	4/5/2004	1425	10.101	4533.632	5.700	91.000	7.720	1.500	0.150	22.000	0.025	6.400	0.250	6.800	35.200
	5/20/2004	1000	31.650	14205.470	13.200	79.000	9.310	18.000	0.376	20.000	0.025	13.800	0.250	6.600	27.800
	6/24/2004	1030	4.425	1986.073	14.400	106.000	7.680	1.500	0.574	36.000	0.056	0.600	0.250	6.800	30.200
	8/18/2004	1230	1.534	688.505	17.500	150.000	7.980	1.500	0.560	56.000	0.060	-18.000	0.250	7.000	40.300
AVERAGE			**10.275**	**4611.878**	**9.700**	**106.833**	**7.578**	**6.667**	**0.388**	**32.333**	**0.036**	**0.467**	**0.250**	**6.917**	**33.800**
STAND. DEV			**11.192**	**5023.189**	**6.467**	**24.145**	**1.102**	**8.029**	**0.160**	**13.530**	**0.017**	**10.530**	**0.000**	**0.240**	**4.985**
BBSC7	10/28/2003	1145	9.624	4319.540	7.500	114.000	6.080	1.500	0.150	36.000	0.025	0.000	0.250	7.300	38.300
	1/14/2004	825	na	na	na	na	na	10.000	0.150	35.200	0.025	0.000	0.250	7.400	44.400
	4/6/2004	810	6.312	2833.015	4.900	87.000	9.170	2.750	0.233	22.000	0.025	6.500	0.250	6.500	28.600
	5/20/2004	915	22.610	10148.046	13.400	82.000	8.090	12.000	0.610	26.000	0.025	10.000	0.250	6.650	24.200
	6/28/2004	1125	2.242	1006.277	14.400	131.000	7.500	4.750	0.401	44.000	0.063	-8.900	0.250	6.900	38.600
	8/18/2004	1100	0.802	359.962	16.700	159.000	7.420	1.500	0.680	44.000	0.094	-26.400	0.250	6.800	49.700
AVERAGE			**8.318**	**3733.368**	**11.380**	**114.600**	**7.652**	**5.417**	**0.371**	**34.533**	**0.043**	**-3.133**	**0.250**	**6.925**	**37.300**
STAND. DEV			**8.709**	**3908.939**	**4.964**	**31.879**	**1.123**	**4.530**	**0.232**	**9.075**	**0.029**	**13.111**	**0.000**	**0.357**	**9.531**

Attachment G

TMDLs and NPDES Permitting Coordination

NPDES permitting is unavoidably linked to TMDLs through WLAs and their translation, through the permitting program, to effluent limits. Primary responsibility for NPDES permitting rests with the District Mining Offices (for mining NPDES permits) and the Regional Offices (for industrial NPDES permits). Therefore, the DMOs and Regions will maintain tracking mechanisms of available WLAs, etc., in their respective offices. The TMDL program will assist in this effort. However, the primary role of the TMDL program is TMDL development and revision/amendment (the necessity for which is as defined in the Future Modifications section) at the request of the respective office. All efforts will be made to coordinate public notice periods for TMDL revisions and permit renewals/reissuances.

Load Tracking Mechanisms

PADEP has developed tracking mechanisms that will allow for accounting of pollution loads in TMDL watersheds. This will allow permit writers to have information on how allocations have been distributed throughout the watershed in the watershed of interest while making permitting decisions. These tracking mechanisms will allow PADEP to make minor changes in WLAs without the need for USEPA to review and approve a revised TMDL. Tracking will also allow for the evaluation of loads at downstream points throughout a watershed to ensure no downstream impairments will result from the addition, modification, or movement of a permit.

Options for Permittees in TMDL Watersheds

PADEP is working to develop options for mining permits in watersheds with approved TMDLs.

Options identified

- Build excess WLA into the TMDL for anticipated future mining. This could then be used for a new permit. Permittee must show that there has been actual load reduction in the amount of the proposed permit or must include a schedule to guarantee the reductions using current data referenced to the TMDL prior to permit issuance.
- Use WLA that is freed up from another permit in the watershed when that site is reclaimed. If no permits have been recently reclaimed, it may be necessary to delay permit issuance until additional WLA becomes available.
- Re-allocate the WLA(s) of existing permits. WLAs could be reallocated based on actual flows (as opposed to design flows) or smaller than approved pit/spoil areas (as opposed to default areas). The "freed-up" WLA could be applied to the new permit. This option would require the simultaneous amendment of the permits involved in the reallocation.
- Non-discharge alternative.

Other possible options

The following two options have also been identified for use in TMDL watersheds. However, before recommendation for use as viable implementation options, a thorough regulatory (both state and federal) review must be completed. These options should not be implemented until the completion of the regulatory review and development of any applicable administrative mechanisms.

- Issue the permit with instream water quality criteria values as the effluent limits. The instream criteria value would represent the monthly average, with the other limits adjusted accordingly (e.g., for Fe, the limits would be 1.5 mg/L monthly average, 3.0 mg/L daily average and 4.0 instantaneous max mg/L).

The applicant would agree to treat an existing source (point or nonpoint) where there is no responsible party and receive a WLA based on a portion of the load reduction to be achieved. The result of using these types of offsets in permitting is a net improvement in long-term water quality through the reclamation or treatment of an abandoned source.

Attachment H
Comment and Response