Two Mile Run Watershed TMDL

For Acid Mine Drainage Affected Segments

Prepared by the Pennsylvania Department of Environmental Protection

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Total Maximum Daily Loads
Two Mile Run Watershed
Leidy and Noyes Townships, Clinton County, PA

Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Two Mile Run Watershed (Attachments A and B). It was done to address the impairments noted on the 1996 Pennsylvania 303(d) list, required under the Clean Water Act, and covers three segments on this list and one additional non-listed segment (Robbins Hollow Run, shown in Table 1). Furthermore, there is a segment on the list that was not assessed for this report because it is not impaired by AMD. This segment is an unnamed tributary to Huling Branch, DEP Stream Code 23665, and is also shown below in Table 1. High levels of metals, and in some areas depressed pH, caused these impairments. All impairments resulted from acid mine drainage (AMD) from abandoned coal mines. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum) and pH.

Table 1. 303(d) Sub-List								
State Water Plan (SWP) Subbasin: 09-B Kettle Creek								
Year	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	Source	EPA 305(b) Cause Code
1996	1.9	7131	23663	Two Mile Run	TSF	305(b) Report	RE	Metals
1998	1.93	7131	23663	Two Mile Run	TSF	SWMP	AMD	Metals, pH & Siltation*
2000	2.36	990512-1300-TAS	23663	Two Mile Run	TSF	SWMP	AMD	Metals, pH
1996	2.1	7132	23670	Middle Branch	TSF	305(b) Report	RE	Metals
1998	2.08	7132	23670	Middle Branch	TSF	SWMP	AMD	Metals
2000	2.08	990512-1400-TAS	23670	Middle Branch	TSF	SWMP	AMD	pH
1996	Not in 1996 303(d) List			Huling Branch	TSF			
1998	Not in 1998 303(d) List			Huling Branch	TSF			
2000	4.16	990512-1210-TAS	23664	Huling Branch	TSF	305(b) Report	AMD	Metals, pH
1996	Not in 1996 303(d) List			UNT Huling Branch	TSF			
1998	Not in 1998 303(d) List			UNT Huling Branch	TSF			
2000	0.69	990512-1210-TAS	23665	UNT Huling Branch	TSF	305(b) Report	AMD	Metals, pH

*The siltation listing will be addressed in a future TMDL.
TSF = Trout Stocked Fishery
AMD = Abandoned Mine Drainage
SWMP = Surface Water Monitoring Program

Directions to the Two Mile Run Watershed

The Two Mile Run watershed contains all four affected stream segments covered under this TMDL report. They are Two Mile Run and its tributaries, Huling Branch, UNT to Huling Branch, Middle Branch, and Robbins Hollow Run (not on the 303(d) list or Table 1). Two Mile Run is a tributary to Kettle Creek, and Kettle Creek flows into the West Branch of the Susquehanna river west of Renovo. Specifically, the confluence of Kettle Creek and the West Branch Susquehanna is at the village of Westport, five miles west along State Route 120 from the western intersection of State Routes 120 and 144. From Westport, the confluence of Two Mile Run and Kettle Creek is approximately one and two-thirds miles north along S.R. 4001, herein referred to as the Kettle Creek road. From the intersection of the "Two Mile Run" road and Kettle Creek road, Huling Branch enters Two Mile Run from the west, about one-quarter mile north along the Two Mile Run road. Also from the Kettle Creek road and Two Mile Run road intersection, Robbins Hollow Run enters Two Mile Run from the east about one and eight-tenths miles north along Two Mile Run road, and Middle Branch enters Two Mile Run from the west about one and nine-tenths miles north along Two Mile Run road.

Segments Addressed in this TMDL

The four distinct stream segments assessed in this report, Two Mile Run, Huling Branch, Robbins Hollow Run, and Middle Branch, were affected by past coal mines in the watershed, none of which are active today. Therefore, all the mine discharges and base-flow pollution are from abandoned mine sites and will be treated as non-point sources. The distinction between non-point and point sources in this case is determined on the basis of whether or not there is a responsible party for the discharge. Where there is no responsible party, the discharge is considered to be a non-point source. Each segment on the 303(d) list, except for the unnamed tributary to Huling Branch, will be addressed as a separate TMDL. Furthermore, the Robbins Hollow Run segment, which is not on the 303(d) list, will be included and assessed as a separate TMDL. The short segments listed in Table 1 as Mackintosh Hollow Run and Pecking Patch Hollow Run, which are not on the 303(d) list either, will not be included in the TMDL assessment. These "stream" channels will be discussed later in the report. The TMDLs for each segment 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.

In PA Title 25, Chapter 93, Kettle Creek is designated as a Trout Stocked Fishery (TSF) from the Alvin R. Bush dam to its mouth. However, Kettle Creek becomes impacted by mine drainage about three miles below the dam. And where Two Mile Run enters, about six miles below the dam, Kettle Creek is no longer suitable for stocking and maintaining trout populations. As a tributary to Kettle Creek, Two Mile Run should also have the designation as a Trout Stocked Fishery. But the lower stretches of Two Mile Run and its main tributaries are severely impacted by mine drainage and support no aquatic life. Nevertheless, Two Mile Run, Middle Branch, and Huling Branch all have good water quality and even support native trout upstream of the abandoned coal mines. Robbins Hollow Run is affected nearly to its source.

The Two Mile Run watershed, depicted in Attachment B, covers an area of about 9.2 square miles. Two Mile Run originates close to 1700 feet in elevation within the northwest corner of the Renovo West 7½ minute quadrangle just north of a dirt road known as the Boyer road. The mouth of Two Mile Run at Kettle Creek is approximately 705 feet in elevation. The total stream length is approximately 4.6 miles. The stream is first impacted by AMD at elevation 1240 feet, where drainage from a large mine seepage area enters the stream from the eastern side (see sample point SWMP2 on Attachment B). The total affected length of Two Mile Run from this point to the mouth is approximately 2.4 miles. Two Mile Run becomes increasingly degraded as it flows toward Kettle Creek. The main sampling stations on Two Mile Run are TM-1, TM 1A, TM-2, TM-3, TM-3A, TM-4, TM-5 and TM-5A. Station TM-1 is located near the mouth, just below the bridge of Kettle Creek road. Station TM2 is located just before the confluence with Huling Branch. Station TM-3 is located just after the confluence with Robbins Hollow Run. Station TM-4 is located just before the confluence with Middle Branch. And station TM-5 is the upstream sampling point above the impacts of SWMP2 and all coal mine drainage. TM-5A is upstream of sampling point TM-5. Also, there are stations where sampling was conducted briefly at TM-1A and TM-3A. Station TM-1A is located between TM1 and TM-2, about 100 feet below the confluence of Huling Branch and Two Mile Run. Station TM-3A is located between TM3 and TM4, about 100 feet below the confluence of Middle Branch and Two Mile Run.

Segments Not Addressed in this TMDL

One stream segment that is on the 303(d) list as being impaired, but that is not specifically addressed in this TMDL report, is the unnamed tributary to Huling Branch. This small stream segment of just 0.69 miles in length is not impaired by past mining activities. It enters Huling Branch from the west, just below sampling station HB12, and should receive little if any surface and groundwater runoff from the abandoned coal mines. A sample was collected recently from near the mouth of this tributary, designated as HB-13, and the sample revealed the water to be net alkaline with low metals and sulfates. This segment is a candidate for future delisting.

Other tributaries to the impaired segment of Two Mile Run, Mackintosh Hollow Run and Pecking Patch Hollow Run, are also not addressed in this report or placed on the 303(d) list. Mackintosh Hollow Run is draining an area that was not mined (see next section of this report) and is therefore unaffected by mine drainage. It also does not reach Two Mile Run via surface flow, but rather it disappears beneath the colluvium. The “downstream” sample collected on this tributary, sampling station MH1, was collected on the hillside well above Two Mile Run. As for Pecking Patch Hollow, this is a tributary that receives mine drainage at its headwaters, but it also does not reach Two Mile Run via direct surface flow. Unlike Robbins Hollow Run, it enters the groundwater system beneath the colluvium and recharges Two Mile Run at or just below sampling station TM-2.

Geology and Mining History of the Watershed

The structural geology of the Two Mile Run watershed is influenced by the presence of the Clearfield-McIntyre Syncline, whose axis strikes approximately north 40° east and intersects Huling Branch about two-tenths of a mile from its confluence with Two Mile Run. This syncline has a local basin that is centered near the southeastern nose of the ridge between Huling Branch and Kettle Creek. As with many synclinal structures in this area, the limbs of the syncline are relatively shallow in dip close to the axis. But farther from the axis, the underlying strata rise markedly. In this watershed, the northwestern flank of the syncline increases its dip about two-thirds of a mile from the axis. This increase in dip is responsible for the rapid rise in the coal measures to the northwest, limiting the mining of marketable seams to about two miles from the synclinal axis, thereby protecting the upper reaches of the impacted streams.

The marketable coal seams within the Two Mile Run watershed are limited for the most part to the Lower Kittanning and "Upper Kittanning" coals. The Kettle Creek Scarlift report[1] identified the upper seam mined as the Upper Kittanning, probably due to its position of about 100 feet or more above the Lower Kittanning seam. However, there does not seem to be any limestone or calcareous rocks of any kind at what would be the Johnstown horizon beneath the Upper Kittanning coal. And if this seam is correctly identified as the Upper Kittanning, then the Middle Kittanning coal is generally absent in this area. For the purposes of this report, we will maintain the Scarlift correlation and refer to the upper mineable coal seam as the Upper Kittanning.

The Lower Kittanning coal seam ranges in elevation from a high of about 1600 feet on the ridge between Huling Branch and Middle Branch to a low of about 1340 feet near the synclinal basin at the southeastern nose of the ridge between Huling Branch and Kettle Creek. This is a structural relief of more than 250 feet. The Upper Kittanning coal seam was mined only in limited areas where that coal strata was not eroded away. In this watershed, the Upper Kittanning stratum is present on the highs of the ridge between Huling Branch and Two Mile Run, on the ridge between Huling Branch and Kettle Creek, and on the ridge east of Two Mile Run and north of Pecking Patch Hollow. By far, the Lower Kittanning coal was the main seam mined in this watershed. Drill logs also show the presence of some Clarion coals and associated clay, but these seams are very thin and were not targeted for much mining. A Clarion mine was permitted in the recent past between Middle Branch and Two Mile Run, but very little ground was disturbed before the permittee closed operations.

We know little of the details regarding the past mining activities within the Two Mile Run watershed. Therefore, we will only provide a general discussion regarding the past mining. According to the Scarlift report, Kettle Creek Coal Company began large-scale mining in the early part of the twentieth century on the Lower Kittanning seam. They extracted the coal primarily by underground methods on the west side of Kettle Creek in the vicinity of the village of Bitumen. They mined the coal through a series of interconnected deep mines until closing operations for good about 1929. East of Kettle Creek within the Two Mile Run watershed, underground mines on the Lower Kittanning coal are also prevalent beneath the ridges separating Two Mile Run and its main tributaries. However, it is not known whether Kettle Creek Coal Company was also involved in deep mining east of Kettle Creek. The Scarlift report suggests that the underground mines within the Two Mile Run watershed were operated by individuals and partnerships, and that several of the mines were identified by the particular operator; e.g. Pedokus Mine, Winkleman Mine, and Desmond Brothers Mine. Also according to the Scarlift

[1] Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Planning and Developmental Research, Operation Scarlift Project SL-115, Mine Drainage Pollution Abatement, Kettle Creek, Clinton County, Pennsylvania, December 1972, The Neilan Engineers, Inc., Somerset, Pennsylvania

report, very little if any deep mining was conducted on the Upper Kittanning seam within the Two Mile Run watershed, and the deep mining that took place on the Lower Kittanning left significant reserves around the cropline. Therefore, by the time surface mining methods were introduced to this area in the 1950s, there was a substantial amount of coal to be recovered.

Beginning sometime in the 1950s, D. G. Wertz strip mined crop areas of the Lower Kittanning coal under shallow cover (less than 40 feet) and worked the Upper Kittanning seam where present beneath isolated hillocks. Later, Kettle Creek Corporation began operations and stripped the Lower Kittanning to a higher cover (approximately 60 feet). D. G. Wertz also set up a coal cleaning plant on the east side of Huling Branch about two miles above the mouth. Evidence of this plant area is visible today. In the 1970s, Richmont Coal Company permitted large tracts of land for additional strip mining. However, not all of their planned permitted areas were mined. One part of Richmont Coal's permitted area that was not mined is of particular interest. The large tract of land north, south, and east of Mackintosh Hollow was not surface mined, although drilling records from Richmont Coal's exploratory drilling indicated coal was present there. We do not know if there are any underground mines in this area either, although we suspect there were none. This is an area where the available drilling information is sparse. Consequently, the geology is not as well understood there, and there may be some aberrations in the coal stratigraphy; e.g. unusual rolls, thinning, want areas, or even changes to the quality of the coal. According to the expected Lower Kittanning coal horizon, that coal should be present over a large area east of Mackintosh Hollow. Nevertheless, the quality of water draining Mackintosh Hollow is alkaline with low sulfates, indicating no mining had taken place in that subwatershed.

The end result of these decades of mining was that the Lower Kittanning coal seam had been mined extensively throughout the watershed by underground workings. Along the coal cropline, contour surface mining had removed the Lower Kittanning coal around the hillsides of the steep-sided ridges. Area surface mining methods were used to completely remove the coal from beneath those hilltops farther from the synclinal axis where the coal seam rises steeply and the cover is not as deep. The Upper Kittanning coal was completely mined everywhere it was present beneath small hillocks on the tops of the ridges.

The past coal mine operators accomplished very little reclamation as compared to today's standards. The deep mining companies did not seal their drift entries after the mines were exhausted. However, many entries were sealed under WPA work projects , although subsequent strip mining destroyed many of the seals. The strip miners did not conduct backfilling, with the exception of those cuts that were covered during normal mining operations. Little or no regrading, top-soiling, and revegetation were accomplished. Consequently, precipitation (rainfall and snowmelt) easily soaks into abandoned mining cuts and gently-sloping spoils, thereby percolating through pyritic rock, buried refuse, and underground mine workings. Where the exposed mine spoils are steep, the rainfall easily erodes the loose material and washes it into the receiving streams.

Numerous surface and underground mine discharges exist throughout the disturbed portion of the watershed at the toe of the mining areas or at the surface contact of underlying aquifers. The discharges emanating from polluted aquifers that underlie the mined areas result in large "kill zones" where the mine drainage seeps from the ground over broad areas, depositing iron precipitates and destroying all vegetation. One good example of a broad discharge area is that which contributes to SWMP2 from the northernmost mine area on the east side of Two Mile Run. Another AMD kill zone is that which contributes polluted drainage to Huling Branch from the northernmost mining area between Huling Branch and Middle Branch. Furthermore, the pollution originating within the mine spoils and underground workings may penetrate into much deeper aquifers, or follow the near-surface fracture zone along the hillsides to enter the receiving streams through groundwater recharge. Springs such as SLB2, SLB4, and SLB9 that emerge near the elevation of Two Mile Run exhibit characteristics of acid mine drainage.

As mentioned previously, there is a broad area of the watershed where past coal mining had not occurred, but the geology is not well defined to explain this absence of mining. This area is west of Two Mile Run within the headwaters of Mackintosh Hollow, between the mining that took place within the Robbins Hollow subwatershed and the mining north of Pecking Patch Hollow. Richmont Coal Company did not affect this area, although it was certainly part of their plans during the permit application process. We do not know why the Lower Kittanning was not mined there, because Richmont's exploratory drilling did indicate the presence of coal. Nevertheless, the available drilling information is sparse in places, and the coal stratigraphy that is revealed does not correlate well with the mining areas to the north and south. A more in-depth study and additional drilling may be necessary to fully understand the geology of this area.

In any event, the quality of surface and groundwaters associated with Mackintosh Hollow reflect this absence of coal mining. Samples collected from within the Mackintosh Hollow tributary channel (MH-1) and a spring just to the south (SLB-7) reveal waters that are net alkaline with low sulfate concentrations. Therefore, groundwater runoff from this broad area into Two Mile Run should help to reduce the concentration of pollutants. And if some metals precipitate within the stream bed as a result of mixing with these more alkaline waters, then the pollutional loading may even be reduced. Unfortunately, our stream sampling during 1999 and 2000 suggests that pollutional loading continues to increase within Two Mile Run from the confluence with Robbins Hollow Run to just before Huling Branch. Therefore, additional pollution is contributing to Two Mile Run along this stretch of the stream, most likely from the western side, associated with mining on the ridge between Two Mile Run and Huling Branch, and from the east where abandoned mines exist at and north of Pecking Patch Hollow.

TMDL Endpoints

One of the major components of a TMDL is the establishment of an instream numeric endpoint, which is used to evaluate the attainment of acceptable water quality. An instream numeric endpoint, therefore, represents the water quality goal that is to be achieved by implementing the load reductions specified in the TMDL. The endpoint allows for 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 of the nature of the pollution sources in the watershed, most of the TMDLs' component makeup will be Load Allocations (LA) that are specified above a point in the stream segment. All allocations will be specified as long-term average concentrations. These long-term average concentrations are expected to meet water-quality criteria 99% of the time. PA Title 25 Chapter

93.5(b) specifies that a minimum 99% level of protection is required. All metals criteria evaluated in these TMDLs are specified as total recoverable. The data used for this analysis report iron as total recoverable. 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*	0.1 of the 96 hour LC 50 0.75	Total recoverable
Iron	1.50 0.3	Total recoverable dissolved
Manganese	1.00	Total recoverable
PH**	6 - 9	NA

- *- This TMDL was developed using the value of 0.75 mg/l as the in-stream criterion for aluminum. This is the EPA national acute fish and aquatic life criterion for aluminum. Pennsylvania's current aluminum criterion is 0.1 mg/l of the 96-hour LC-50 and is contained in PA Title 25 Chapter 93. The EPA national criterion was used because the Department has recommended adopting the EPA criterion and is awaiting final promulgation of it.
- ** - 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). This condition is met when the net alkalinity is maintained above zero.

Computational Methodology

A TMDL equation consists of a Wasteload Allocation (WLA), Load Allocation (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 Non-point Sources (NPS). The MOS is applied to account for uncertainties in the TMDL. The MOS may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

Table 3. Two Mile Run Regressions					
Sample Point ID	**Flow vs**				**Number of Samples**
	Aluminum	**Iron**	**Manganese**	**Acidity**	
newMB-1	0.18	0.01	0.36	0.13	48

Regressions for flow and each parameter (Table 3.) were calculated for Middle Branch (MB-1) only, the other sampling points did not have enough data points. There are no significant correlations between source flows and pollutant concentrations. Analyses of the data could not determine a critical flow at any sample point.

For purposes of this TMDL, point sources are identified as permitted discharge points and nonpoint sources are other discharges from abandoned mine lands which includes tunnel discharges, seeps (although none were specifically identified), and surface runoff. Abandoned and reclaimed mine lands are treated in the allocations as nonpoint sources because there are no NPDES permits associated with these areas. As such, the discharges associated with these lands were assigned load allocations (as opposed to wasteload allocations).

TMDLs and LAs for each parameter were determined using Monte Carlo simulation. For each source and pollutant, it was assumed that the observed data are log-normally distributed. The lognormal distribution has long been assumed when dealing with environmental data.

Each pollutant source was evaluated separately using @Risk[2]. Five thousand iterations were performed to determine the required percent reduction so that water-quality criteria will be met in-stream at least 99 percent of the time. For each iteration, the required percent reduction is:

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

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

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

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

The overall percent reduction required is the 99th percentile value of the probability distribution generated by the 5000 iterations, so that the allowable long-term average (LTA) concentration is:

LTA = Mean * (1 – PR_{99}) where (2)

LTA = allowable LTA source concentration in mg/l (the mean of five thousand iterations, from the statistics portion of the @Risk program.)

An example calculation, including detailed tabular summaries of the Monte Carlo results is presented for the Lorberry Creek TMDL in Attachment D.

[2] @ Risk - Risk Analysis and Simulation Add-in for "Micorsoft Excel", Palisade Corporation, Newfield , NY, 1990-1997

Two Mile Run, Sample Point TM-4

TMDL calculations

The TMDL for Two Mile Run consists of a load allocation to all of the area above sampling point TM-4 (Attachment B). This is the first stream monitoring point that a TMDL will be calculated for. Addressing the mining impacts above this point addresses the impairment for the stream segment above this point on Two Mile Run.

There is currently an entry for this segment on the Pa 303(d) list for impairment due to pH. Sample data at point TM-4 shows a pH of 4.5. For this reason pH will be addressed as part of this TMDL. Upstream samples taken at sampling point TM-5A do not indicate mining impacts however, pH at TM-5A ranges between 5.5 and 5.7. The objective is to reduce acid loading to the stream which will in turn raise the pH to the desired range. Sampling point TM-4 has the lowest pH so the alkalinity at TM-4 will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at point TM-4. The average flow (1.0 MGD) was used.

An allowable long-term average in-stream concentration was determined at point TM-4 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 4. shows the load allocations for this stream segment.

Table 4. Two Mile Run					
TM-4	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)	%
Al	9.11	76.1	0.27	2.3	97%
Fe	0.92	7.7	0.67	5.6	27%
Mn	6.83	57.0	0.27	2.3	96%
Acidity	73.67	615.3	0.15	1.2	99.8%
Alkalinity	0.37	3.1			

The allowable loading values shown in Table 4. represent load allocations made at point TM-4.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from:

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow for this point was used to derive loading values for the TMDL.

Middle Branch

Middle Branch is the first major tributary that joins Two Mile Run, and it enters from the west about two miles above the mouth of Two Mile Run. The Middle Branch enters Two Mile Run about one-third of a mile below the point of first impact on Two Mile Run (confluence of SWMP2 drainage). The Middle Branch originates near 1600 feet in elevation and its total length is just over two miles. The lower "half" of its length is impaired by AMD, below sampling station MB-5. The main sampling stations on the Middle Branch are MB-1, MB-3, and MB-5. Station MB-1 is located near the mouth. Station MB-3 is located midstream, just below the confluence with the surface and underground coal mine drainage that first impacts the stream. Station MB-5 is the upstream sampling point before the access road and above the impacts of all coal mine drainage.

TMDL Calculations

The TMDL for Middle Branch consists of a load allocation to all of the area above the point MB-1 shown in Attachment B. This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with Two Mile Run.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. The sample data that is available above sample point MD-1 (MB-5) has an upstream pH of 5.5. Sample data at point MB-1 shows pH ranging between 4.0 and 4.3; pH will be addressed as part of this TMDL because of the mining impacts. Sampling point MB-1 has the lowest pH so the alkalinity at MB-1 will be used in the evaluation. The objective is to reduce acid loading to the stream which will in turn raise the pH. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at the point MB-1. The average flow (0.62 MGD) available at sampling point MB-1 was used.

An allowable long-term average in-stream concentration was determined at point MB-1 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 5. shows the load allocations for this stream segment.

Table 5. Middle Branch					
MB-1	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)	%
Al	4.75	24.6	0.29	1.5	94%
Fe	0.22	1.1	0.22	1.1	0%
Mn	1.66	8.5	0.41	2.1	75%
Acidity	41.74	216.3	0.38	1.9	99%
Alkalinity	0.72	3.7			

The allowable loading values shown in Table 5. represent load allocations made at point MB-1.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from:

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow available at point MB-1 was used.

Robbins Hollow Run

Although not on the 303(d) list, Robbins Hollow Run is an AMD affected tributary to Two Mile Run that was addressed in this report. This stream enters Two Mile Run from the east just a couple hundred feet below the mouth of Middle Branch. It originates below old mining spoils and underground workings at about 1400 feet in elevation. The total stream length is about eight-tenths of a mile. This tributary becomes increasingly degraded as it flows toward its confluence with Two Mile Run. The main sampling stations on this stream are RH-1, RH-2, and RH-3. Station RH-1 is located at the mouth. Station RH-2 is located midstream at the Bureau of Abandoned Mine Reclamation (BAMR) weir (BAMR's Site #5) and below a significant amount of mine drainage pollution. Station RH-3 is located at the "woods" access road above RH-2 but still below some surface and underground coal mine drainage.

TMDL Calculations

The TMDL for Robbins Hollow Run consists of a load allocation to all of the area above the point RH-1 shown in Attachment B. This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with Two Mile Run.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH. The sample available above point RH-1 (RH-3) shows instream pH varying between 4.0 and 4.5. Sample data at point RH-1 shows pH ranging between 4.0 and 4.5; pH will be addressed as part of this TMDL. Sampling point MB-1 has the lowest pH so the alkalinity at MB-1 will be used in the evaluation. The objective is to reduce acid loading to the stream which will in turn raise the pH. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at point RH-1. The average flow measurement (0.17 MGD) for point RH-1 was used

An allowable long-term average in-stream concentration was determined at point RH-1 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 Iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 6. shows the load allocations for this stream segment

Table 6. Robbins Hollow Run					
RH-1	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)	%
Al	11.86	17.3	0.24	0.3	98%
Fe	0.27	0.4	0.27	0.4	0%
Mn	9.59	14.0	0.29	0.4	97%
Acidity	90.67	132.3	0	0	100%
Alkalinity	0	0			

The allowable loading values shown in Table 6. represent load allocations made at point RH-1.

Margin of Safety

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

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow for this point was used to derive loading values for the TMDL

Two Mile, Sample Point TM-2

One impaired tributary of Two Mile Run, Pecking Patch Hollow Run, is not addressed in this report or placed on the 303(d) list. Pecking Patch Hollow is a tributary that receives mine drainage at its headwaters, but it also does not reach Two Mile Run via direct surface flow. Unlike Robbins Hollow Run, it enters the groundwater system beneath the colluvium and recharges Two Mile Run at or just below sampling station TM-2.

Our stream sampling during 1999 and 2000 suggests that pollutional loading continues to increase within Two Mile Run from the confluence with Robbins Hollow Run to just before Huling Branch. Therefore, additional pollution is contributing to Two Mile Run along this stretch of the stream, most likely from the western side, associated with mining on the ridge between Two Mile Run and Huling Branch, and from the east where abandoned mines exist at and north of Pecking Patch Hollow.

TMDL Calculations

The existing and the allowable loading for point TM-2 for all parameters was determined. This was based on the sample data for this point and did not account for any load reductions already specified from upstream sources. The load reductions from points TM-4, MB-1 and RH-1 were summed and represent the upstream load reductions. The upstream load reduction was subtracted from the existing load at point TM-2, and was compared to the allowable load at TM-2 for each parameter, to determine if any further reductions were needed at this point.

The existing and allowable loading values for this stream segment were computed using water-quality sample data collected at sampling point TM-2. The average flow, measured at sampling point TM-2 (3.07 MGD), is used for these computations. This value represents 4 sampling events for this point where flows were also taken at points HB-1 and TM-1A on the same day.

This segment is listed on the Pa 303(d) list for impairment due to metals. Sample data at point TM-2 shows a pH of 4.5. The upstream sample point TM-5A has a pH of 6.0. The objective is to reduce acid loading to the stream which will in turn raise the pH to the desired range. The alkalinity at sampling point TM-2 is lower and will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

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

Table 7. Two Mile Run				
TM-2	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)
Al	7.28	134.91	0.29	5.4
Fe	0.33	6.2	0.33	6.2
Mn	6.43	119.2	0.32	6.0
Acidity	58.33	1081.6	0.47	8.7
Alkalinity	1.03	19.2		

The area of the Two Mile Run watershed upstream of TM-2 is adversely affected by AMD and one or more allocations may be necessary at TM-2. In an effort to determine if there is a need for any allocations at this point the following procedure was used.

The loading reductions for points TM-4, MB-1, and RH-1 were summed to show the total load that was removed from upstream sources. This value, for each parameter was then subtracted from the existing load at point TM-2. This value was then compared to the allowable load at point TM-2. Reductions at point TM-2 are necessary for any parameter that exceeded the allowable load at this point. Table 8. shows a summary of all loads that affect point TM-2. Table 9. illustrates the necessary reductions at point TM-2. The results of this analysis show that reductions for aluminum, manganese and acidity are necessary at this point.

Table 8. Summary of All Loads that Affect TM-2				
	Al (#/day)	**Fe (#/day)**	**Mn (#/**day**)**	**Acidity (#/**day**)**
Two Mile Run (TM-4)				
load reduction=	73.8	2.1	54.8	614.1
Middle Branch (MB-1)				
load reduction=	23.2	0.0	6.3	214.3
Robbins Hollow RH-1				
load reduction=	17.0	0	13.6	132.3

Table 9. Necessary Reductions at Sample Point TM-2

	Al (#/day)	Fe (#/day)	Mn (#/day)	Acidity (#/day)
Existing Loads at TM-2	191.9	10.5	172.3	1552.2
Total Load Reduction (Sum of TM-4, MB-1 & RH-1)	113.9	2.1	74.7	960.7
Remaining Load (Existing Loads at TM-2 – TLR Sum)	78.0	8.4	97.7	591.5
Allowable Loads at TM-2	6.3	10.5	6.9	15.5
Percent Reduction	92%	NA	92.9%	97.4%
Additional Removal Required at TM-2	71.7	NA	90.8	576.0

The allowable loading values shown in Table 9. represent load allocations made at point TM-2.

The load allocation for this stream segment was computed using water-quality sample data collected at point TM-2 and the allowable loads from TM-4, MB-1 and RH-1. The average flow, measured at sample point TM-2, is used for these computations. The TMDL for TM-2 consists of load allocations for aluminum, manganese and acidity to all of the area above point TM-2. The Percent Reduction in Table 8., above, is calculated (refer to Table 8.):

$$\left[1-\left(\frac{\text{Allowable Loads at TM - 2}}{\text{Remaining Load (Existing Loads at TM - 2 - TLR Sum}}\right)\right]\times 100\,\%$$

No additional loading reductions were necessary for iron.

Margin of Safety

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from.

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow, measured at sample point TM-2, is used for these computations.

Huling Branch

Huling Branch is a major tributary whose overall length nearly matches that of Two Mile Run. Huling Branch joins Two Mile Run about three-tenths of a mile above the mouth. Like Two Mile Run, it also originates near 1700 feet in elevation, within the northeast corner of the Keating 7 ½ minute quadrangle. Its total length is about 4.2 miles, with the lower two and one-half miles impacted by AMD. The main sampling stations on Huling Branch are HB-1, HB-2, HB-3, HB-4, and HB-12. Station HB-1 is located at the mouth. Station HB-2 is located about four-tenths of a mile above the mouth. Station HB-3 is located about one mile above the mouth. Station HB-4 is located midstream about one and one-half miles above the mouth, not far below where some major polluted mine drainage enters the stream. And station HB-12, considered the upstream sampling point, is located just above what BAMR describes as the "last clean tributary" into Huling Branch. Incidentally, it is this tributary to Huling Branch that is also placed on the 303(d) list as an impaired waterway. It will be discussed later in this report. According to the historic data, Huling Branch does not exhibit a steady increase in pollution from where it is first affected to the mouth. Nevertheless, it remains one of the most polluted streams in this watershed by the time it reaches its confluence with Two Mile Run. In fact, based upon our sampling and flow measurements during 1999 and 2000, the flow and pollutional loading at the mouth of Huling Branch (HB-1) may equal or exceed that of Two Mile Run just before the confluence (TM-2).

TMDL Calculations

The TMDL for Huling Branch consists of a load allocation to all of the area above the point HB-1 shown in Attachment B. This is the first stream monitoring point downstream of all mining impacts. Addressing the mining impacts above this point addresses the impairment for the entire stream segment to its confluence with Two Mile Run.

There is currently no entry for this segment on the Pa 303(d) list for impairment due to pH . The sample available above point HB-1 (HB-12) shows instream pH varying between 5.1 and 7.1. Sample data at point HB-1 shows pH ranging between 3.1 and 3.7; pH will be addressed as part of this TMDL. Sampling point HB-1 has the lowest pH so the alkalinity at HB-1 will be used in the evaluation. The objective is to reduce acid loading to the stream which will in turn raise the pH. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

The load allocation for this stream segment was computed using water-quality sample data collected at point HB-1. The average flow measurement (2.42 MGD) for point HB-1 was used. This value represents 4 sampling events for this point where flows were also taken at points TM-2 and TM-1A on the same day.

An allowable long-term average in-stream concentration was determined at point HB-1 for aluminum, iron, manganese and acidity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, 5000 Iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards. Table 10. shows the load allocations for this stream segment

Table 10. Huling Branch

HB-1	Measured Sample Data		Allowable		Reduction Identified
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)	%
Al	9.35	147.0	0.19	2.91	98%
Fe	10.00	156.8	0.41	6.48	96%
Mn	6.33	99.5	0.26	4.06	96%
Acidity	119.33	1876.9	0.00	0.00	100%
Alkalinity	0	0			

The allowable loading values shown in Table 10. represent load allocations made at point HB-1.

<u>Margin of Safety</u>

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

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow for this point was used to derive loading values for the TMDL.

Two Mile Run, Sampling Point TM-1A

The existing and the allowable loading for point TM-1A for all parameters was determined. This was based on the sample data for this point and did not account for any load reductions already specified from upstream sources. The load reductions from points TM-4, MB-1, RH-1, HB-1 and the additional removal required at TM-2 were summed and represent the upstream load reductions. The upstream load reduction was subtracted from the existing load at point TM-1A, and was compared to the allowable load at TM-1A for each parameter, to determine if any further reductions were needed at this point.

The existing and allowable loading values for this stream segment were computed using water-quality sample data collected at sampling point T-1A. The average flow, measured at sampling point TM-1A (5.51 MGD), is used for these computations.

This segment is listed on the Pa 303(d) list for impairment due to metals. Sample data at point TM-1A shows a pH of 4.5. The upstream sampling point, TM-5A, is unaffected by AMD and has a pH of 6.0. The objective is to reduce acid loading to the stream, which will in turn raise the pH to the desired range. The alkalinity at sampling point TM-1A is lower and will be used in the evaluation. The result of this analysis is an acid loading reduction that equates to meeting standards for pH (see Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average in-stream concentration was determined at point TM-1A for aluminum, iron, manganese and alkalinity. The analysis is designed to produce an average value that, when met, will be protective of the water-quality criterion for that parameter 99% of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water-quality criteria 99% of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and standard deviation of the data set, five thousand iterations of sampling were completed, and compared against the water-quality criterion for that parameter. For each sampling event a percent reduction was calculated, if necessary, to meet water-quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99% of the time. The mean value from this data set represents the long-term average concentration that needs to be met to achieve water-quality standards.

Table 11. Two Mile Run				
TM-1A	Measured Sample Data		Allowable	
Parameter	Conc (mg/l)	Load (lbs/day)	LTAConc (mg/l)	Load (lbs/day)
Al	8.57	394.2	0.26	11.8
Fe	5.09	234.2	0.41	18.7
Mn	6.44	296.0	0.26	11.8
Acidity	90.50	4162.7	0	0
Alkalinity	0	0		

The area upstream of TM-1A is adversely affected by abandoned mine drainage and one or more allocations may be necessary at TM-1A. In an effort to determine if there is a need for any allocations at sampling point TM-1A the following procedure was used.

The loading reductions for points TM-4, MB-1, RH-1, HB-1 and the additional removal required at TM-2 were summed to show the total load that was removed from upstream sources. This value, for each parameter, was then subtracted from the existing load at point TM-1A. This value was then compared to the allowable load at point TM-1A. Reductions at point TM-1A are necessary for any parameter that exceeded the allowable load at this point. Table 12. shows a summary of all loads that affect point TM-1A. Table 13. illustrates the necessary reductions at point TM-1A. The results of this analysis show that reductions for aluminum, Iron, Manganese and Acidity are necessary at TM-1A.

Table 12. Summary of All Loads that Affect TM-1A				
	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Sum of TM-4, MB-1 & RH-1 load reductions	113.9	2.1	74.7	960.7
Additional Removal Required at TM-2	71.7	NA	90.8	576.0
HB-1				
load reduction=	144.1	150.3	95.4	1876.9

Table 13. Necessary Reductions at Sample Point TM-1A

	Al (#/day)	**Fe (#/day)**	**Mn (#/day)**	**Acidity (#/day)**
Existing Loads at TM-1A	394.2	234.2	296.0	4162.7
Total Load Reduction (Sum of TM-4, MB-1, RH-1, TM-2 & HB-1)	329.8	152.4	260.9	3413.7
Remaining Load (Existing Loads at TM-1A – TLR Sum)	64.4	81.8	35.1	749.0
Allowable Loads at TM-1A	11.8	18.7	11.8	0
Percent Reduction	81.6%	77.1%	66.3	100%
Additional Removal at TM-1A	52.6	63.1	23.3	749.0

The allowable loading values shown in Table 13. represent load allocations made at point TM-1A.

The load allocation for this stream segment was computed using water-quality sample data collected at point TM-1A and the allowable loads from TM-4, MB-1, RH-1, HB-1 and additional removal required at TM-2. The average flow, measured at sample point TM-1A (2.11 MGD), is used for these computations. The Percent Reduction in Table 12., above, is calculated (refer to Table 12.):

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

The TMDL for TM-1A consists of load allocations for aluminum, iron and acidity for the area above TM-1A.

<u>Margin</u> <u>of</u> <u>Safety</u>

For this study the margin of safety is applied implicitly. A MOS is built in because the allowable concentrations and loadings were simulated using Monte Carlo techniques and employing the @Risk software. Another margin of safety used for this TMDL analysis results from.

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

Seasonal Variation

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

Critical Conditions

The reductions specified in this TMDL apply at all flow conditions. A critical flow condition could not be identified from the data used for this analysis. The average flow, measured at sample point TM-1A, is used for these computations.

Summary of Allocations

This TMDL will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDL may be re-evaluated to reflect current conditions.

Table 14. presents the estimated reductions identified for all points in the watershed.

		Table 14. Summary Table – Two Mile Run Watershed				
Station		Measured Sample Data		Allowable		Reduction Identified
	Parameter	Conc (mg/l)	load (lbs/day)	LTA Conc (mg/l)	load (lbs/day)	%
TM-4	**In-stream monitoring point located on Two Mile Run**					
	Al	9.11	76.1	0.27	2.3	97%
	Fe	0.92	7.7	0.67	5.6	27%
	Mn	6.83	57.0	0.27	2.3	96%
	Acidity	73.67	615.3	0.15	1.23	99.8%
	Alkalinity	0.37	3.1			
MB-1	**In-stream monitoring point located on Middle Branch**					
	Al	4.75	24.6	0.24	1.5	94%
	Fe	0.22	1.1	0.22	1.1	0%
	Mn	1.66	8.5	0.41	2.11	75%
	Acidity	41.74	216.3	0.38	1.9	99%
	Alkalinity	0.72	3.7			
RH-1	**In-stream sampling point located on Robbins Hollow**					
	Al	11.86	17.3	0.24	0.3	98%
	Fe	0.27	0.4	0.27	0.4	0%
	Mn	9.59	14.0	0.29	0.4	97%
	Acidity	90.67	132.3	0	0	100%
	Alkalinity	0	0			
TM-2	**In-stream sampling point located on Two Mile Run**					
	Al	7.28	134.9	NA	NA	92%
	Fe	0.33	6.2	NA	NA	NA
	Mn	6.43	119.2	NA	NA	93%
	Acidity	58.33	1081.6	NA	NA	97%
	Alkalinity	1.03	19.2			
HB-1	**In-stream sampling point located on Huling Branch**					
	Al	9.35	147.1	0.19	2.9	98%
	Fe	9.97	156.8	0.41	6.5	96%
	Mn	6.33	99.5	0.26	4.1	96%
	Acidity	119.33	1876.9	0	0	100%
	Alkalinity	0	0			

Station		Table 14. Summary Table – Two Mile Run Watershed				
		Measured Sample Data		Allowable		Reduction Identified
	Parameter	Conc (mg/l)	load (lbs/day)	LTA Conc (mg/l)	load (lbs/day)	%
TM-1A	**In-stream sampling point located on Two Mile Run**					
	Al	8.57	394.2	NA	NA	82%
	Fe	5.09	234.2	NA	NA	77%
	Mn	6.44	296.0	NA	NA	66%
	Acidity	90.50	4162.7	NA	NA	100%
	Alkalinity	0	0			

All allocations are load allocations to non-point sources. The margin of safety for all points is applied implicitly through the methods used in the computations.

Recommendations

There are no active coal mining operations within the Two Mile Run watershed. Therefore, it is not a simple matter of placing effluent restrictions on industries to reduce the current loading of pollutants, thereby ensuring that the receiving stream quality meets in-stream criteria 99 percent of the time. Rather, the goal of this report is to set levels of pollution reduction for each impacted stream segment that abandoned mine reclamation efforts and discharge treatment can target. Whether these goals can be attained with today's technology and at reasonable cost is not known. It may require more time, possibly decades, for reclamation and treatment technologies to advance such that cleaning up the worst problem areas are practicable. At the same time, time will allow pyritic materials within the abandoned mines to weather further, thereby reducing the pollutional load naturally. Nevertheless, the existing and currently planned remediation efforts in the watershed show some promise and are progressing well. As discussed above, the focus now is on the upper impacted segment of Two Mile Run and its upper tributaries. The impacted waters currently targeted are Middle Branch, the SWMP2 drainage to Two Mile Run, and Robbins Hollow Run. Whether the remediation efforts will be successful enough to return the quality of these impacted segments to the targeted TMDL levels remains to be seen.

For the near future, we recommend continuing to direct our energies toward Two Mile Run. Huling Branch is a very large problem in itself, and the technological feedback we receive from reclamation activities within the Two Mile Run watershed may be put to good use within the Huling Branch watershed. Downstream of the currently planned reclamation activities on Two Mile Run, there are other abandoned mine areas to target. BAMR has identified these problem areas as PA1123 and PA1121. Problem area PA1123 encompasses most of the abandoned Lower Kittanning and Upper Kittanning surface and underground mines on the ridge between Two Mile Run and Huling Branch from about the same latitude as the confluence of Two Mile Run and Middle Branch toward the south-southeast, nearly to the end of the ridge. This problem area contributes to the polluted drainage identified as SLB10, as well as the contaminated groundwater runoff revealed at SLB2 and SLB4. The relatively flat area of SLB10 should be suitable to the construction of passive treatment facilities. Many abandoned open pits and spoil piles should be backfilled, regraded, and revegetated. Furthermore, the large open pit directly upslope of the drainage could be partially filled with lime waste or other alkaline material before it is backfilled. Furthermore, this may be an area where an alkaline recharge pond could be built in order to induce alkaline groundwaters into the area.

Problem area PA1121 encompasses the Lower Kittanning and Upper Kittanning surface and underground mines of Pecking Patch Hollow on the ridge east of the mouth of Two Mile Run. Our sampling points of PPH1, PPH2, and SLB9 reveal the pollution that is draining from these abandoned mines. The relatively flat ground in the vicinity of PPH2 and the major power lines should be suitable for the construction of passive treatment facilities. The abandoned open pits and spoil piles should be backfilled, regraded, and revegetated. Depending on the specifics of this problem area, other remediation techniques may be appropriate as well.

In addition to the reclamation-only activities and applied treatment methods (passive or chemical treatment) to the various problem areas, there has been some discussion about the feasibility of remining in this watershed. This may not sound very sensible, considering the pollutional problems that past mining have caused. Nonetheless, remining may have some remedial value if imported alkaline material is added to the spoils in sufficient quantities to inhibit the production of additional AMD, and possibly even treat some of the existing pollution. Not only does remining present the advantage of backfilling and regrading the exposed cuts and spoils at no cost to the Commonwealth, but remining operations may even remove the underground mine pillars and gob material (backfilled refuse) from beneath the hills that past surface mining did not reach. However, remining must be economically profitable to attract the interest of mining companies. This depends upon many factors, including the quality of the coal, reserves remaining within underground mines, the cost of removing the overburden to extract the coal, the cost of supplemental reclamation that is not tied directly to the remining operations, and the cost of purchasing, trucking, and applying imported alkaline products. As to the expense of alkaline addition, overburden sampling and analysis from drill hole B6-22 revealed that very high alkaline addition rates may be required to prevent the production of additional AMD. In fact, the quality of just the Lower Kittanning overburden from drill hole B6-22 revealed that over 3,000 tons per acre (calcium carbonate equivalency) of imported lime will be necessary just to meet an overall net neutralization potential (NNP) of zero (one to one ratio of neutralization potential to maximum potential acidity). To achieve an NNP of 6 percent of the overburden, the required alkaline addition rates could climb above 5,000 tons per acre.

Although additional overburden holes and analyses will be necessary for site-specific areas, alkaline addition rates similar to those described above would probably render any remining plans economically prohibitive. However, it is possible with the potential availability of Growing Greener and other reclamation grants, that waste lime would be purchased and delivered to the remine area for the coal operator to incorporate into his active mine site. If all costs of purchasing and delivering the lime is covered under a reclamation grant, and a coal operator demonstrates that remining is economically feasible, then complete reclamation of all the abandoned mines, surface and underground, may be possible.

Immediate Goals

In the short term, a comprehensive monitoring program is needed for the next problem areas targeted for reclamation. We recommend that monitoring stations be established about problem areas PA1121 and PA1123. Flumes, weirs, pipes, or other means of obtaining accurate flow measurements will be necessary in order to evaluate the pollutional loading emanating from these sites (such as at PPH2 and SLB10). Furthermore, flow measurement stations must be established on the receiving stream, Two Mile Run, for the purpose of continuing to monitor the effectiveness of all the remediation efforts. Because Two Mile Run is a large stream, and can discharge a high volume of flow during the wet periods of the year, we recommend establishing stations where stream cross section and velocity metering can best be accomplished. Further, a permanent staff gauge should be installed in the stream bed so that measured flows can be associated with stream depth (or stage height on the gauge). After at least one year of monitoring, a graph can be generated that relates the stream flow to the stage height. Thereafter, it will be necessary only to read the stage height to determine the approximate stream flow from the graph.

We recommend establishing stream monitoring stations with accurate flow readings on Two Mile Run at TM1, TM2, TM3, TM4, and TM5. For Huling Branch, in anticipation of future remedial work, we recommend establishing stream monitoring stations with accurate flow measurements at HB1, HB4, and a new station below HB12, after the tributary enters from the west. For Middle Branch, we recommend establishing stream monitoring stations with accurate flow measurements at MB1, MB3, and MB5. For Robbins Hollow Run, we recommend establishing stream monitoring stations with accurate flow measurements at RH1, RH2, and RH3 (there is already a weir at RH2).

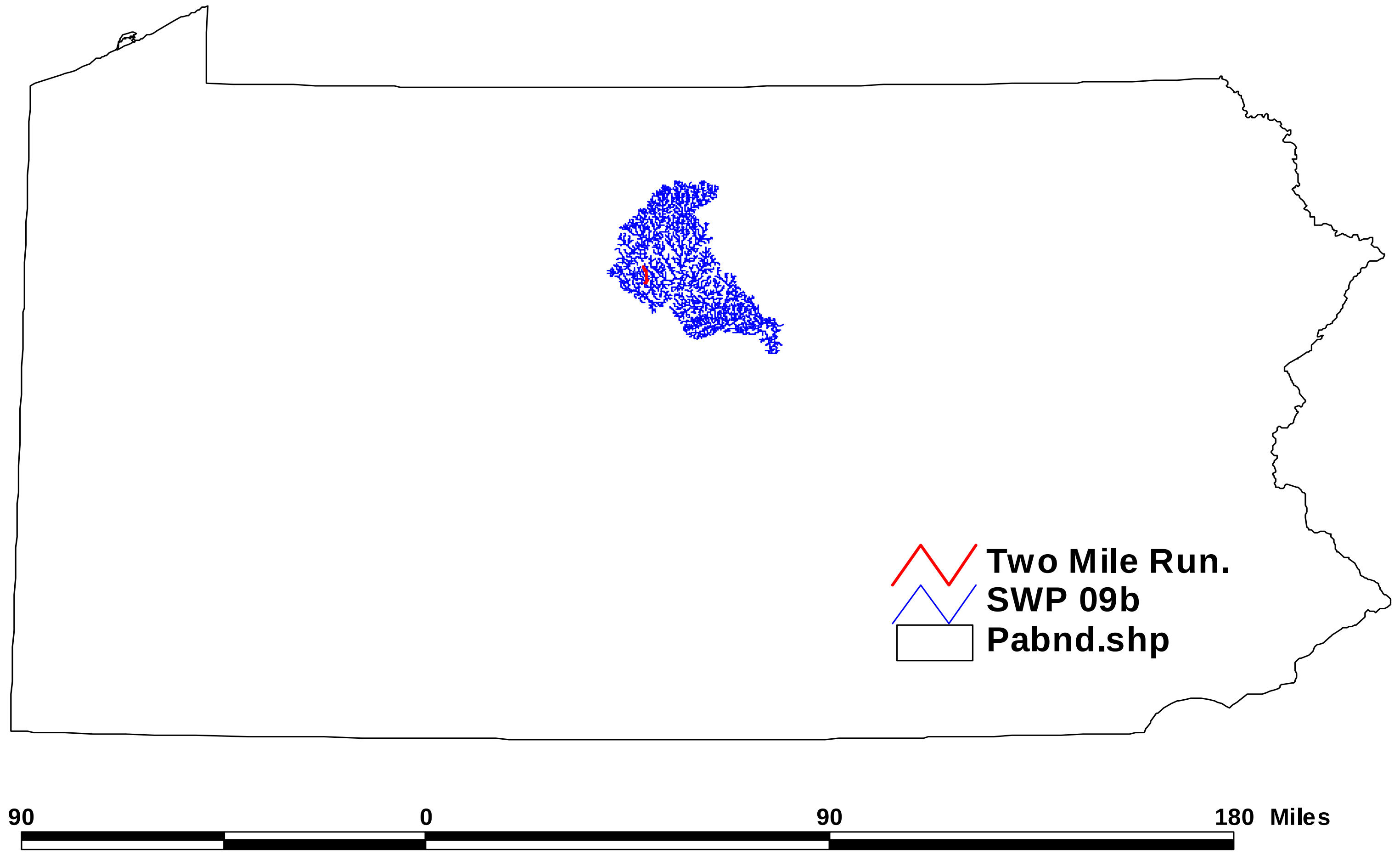
Public Participation

Notice of the draft TMDLs will be published in the *PA Bulletin* and Renovo Record, Renovo, PA with a 60 day comment period ending February 13, 2001 provided. A public meeting with watershed residents was held January 8, 2001at 10:00 am at the Clinton County Conservation District Office in the Porter Township Community Building in Mill Hall, PA to discuss the TMDLs. Notice of final TMDL approval will be posted on the Departments website.

Attachment A

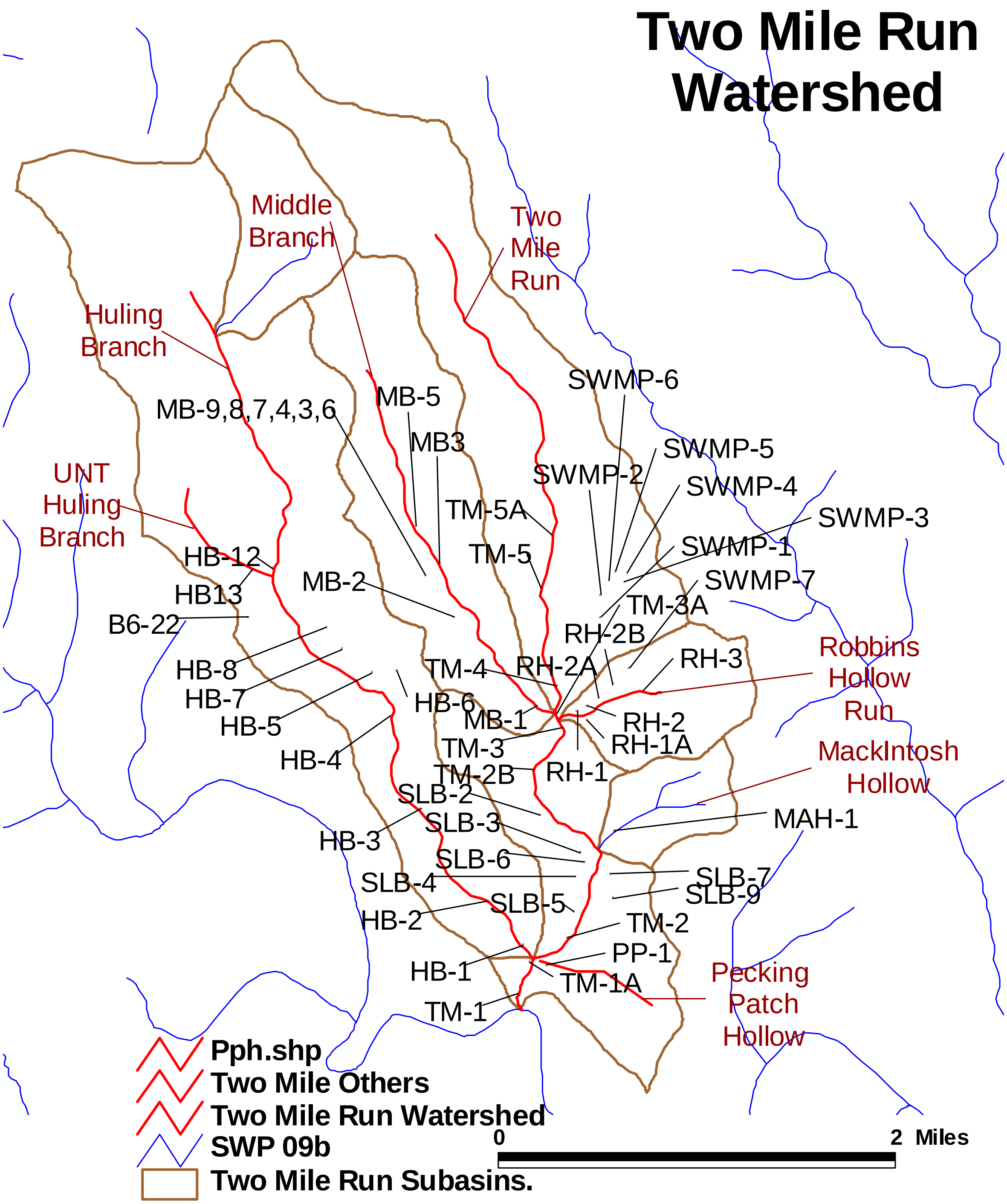
Location of the Two Mile Run Watershed

Two Mile Run Location



Attachment B

Map of the Two Mile Run Watershed


Two Mile Run Watershed
Middle Branch
Two Mile Run
Huling Branch
UNT Huling Branch
MB-9,8,7,4,3,6
MB-5
MB3
SWMP-6
SWMP-5
SWMP-2
SWMP-4
SWMP-3
SWMP-1
SWMP-7
TM-5A
TM-5
TM-3A
HB-12
HB13
B6-22
MB-2
RH-2B
RH-3
Robbins Hollow Run
HB-8
HB-7
HB-5
HB-4
TM-4
RH-2A
HB-6
MB-1
RH-2
RH-1A
TM-3
TM-2B
RH-1
MackIntosh Hollow
SLB-2
SLB-3
MAH-1
HB-3
SLB-6
SLB-4
SLB-7
SLB-9
SLB-5
HB-2
TM-2
PP-1
Pecking Patch Hollow
HB-1
TM-1A
TM-1
Pph.shp
Two Mile Others
Two Mile Run Watershed
SWP 09b
Two Mile Run Subasins.
0
2 Miles

Attachment C

The pH Method

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[3] by the PA Department of Environmental Protection demonstrates, that by plotting net alkalinity vs. pH for 794 mine sample points, where net alkalinity is positive (greater or equal to zero), the pH range is most commonly 6 to 8, which is within the EPA's acceptable range of 6 to 9, and meets Pennsylvania water quality criteria in Chapter 93. The included graph (page 3) presents the nonlinear relationship between net alkalinity and pH. The nonlinear positive relation between net alkalinity and pH indicates that pH generally will decline as net alkalinity declines and vice versa; however, the extent of pH change will vary depending on the buffering capacity of solution. Solutions having near-neutral pH ($6 < pH < 8$) or acidic pH ($2 < pH < 4$) tend to be buffered to remain in their respective pH ranges.[4] Relatively large additions of acid or base will be required to change their pH compared to poorly buffered solutions characterized by intermediate pH ($4 < pH < 6$) where the correlation between net alkalinity and pH is practically zero.

The parameter of pH, a measurement of hydrogen ion acidity presented as a negative logarithm of effective hydrogen ion concentration, is not conducive to standard statistics. Additionally pH does not measure latent acidity that can be produced from hydrolysis of metals. For these reasons PA 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 partially dependent upon metals. For this reason, it is extremely difficult to predict the exact pH values which would result from treatment of acid mine drainage. Therefore, net alkalinity will be used to evaluate pH in these TMDL calculations. This methodology assures that the standard for pH will be met because net alkalinity is able to measure the reduction of acidity. When acidity in a stream is neutralized or is restored to natural levels, pH will be acceptable (>6.0). Therefore, the measured instream alkalinity at the point of evaluation in the stream will serve as the goal for reducing total acidity at that point. The methodology that is applied for alkalinity, (and therefore pH) is the same as that used for other parameters such as iron, aluminum and manganese that have numeric water quality criteria.

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

[3] 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.

[4] Stumm, Werner, and Morgan, J.J., 1996, Aquatic Chemistry--Chemical Equilbria and Rates in Natural Waters (3rd ed.), New York, Wiley-Interscience, 1022p.

There are several documented cases of streams in Pennsylvania having a natural background pH below six. If the natural pH of a stream on the 303-(d) list can be established from its upper unaffected regions, then the pH standard will be expanded to include this natural range. The acceptable net alkalinity of the stream after treatment/abatement in its polluted segment will be the average net alkalinity established from the stream's upper, pristine reaches. In other words, if the pH in an unaffected portion of a stream is found to be naturally occurring below 6, then the average net alkalinity for that portion of the stream will become the criterion for the polluted portion. This "natural net alkalinity level" will be the criterion to which a 99% confidence level will be applied. The pH range will be varied only for streams in which a natural unaffected net alkalinity level can be established. This can only be done for streams that have upper segments that are not impacted by mining activity. All other streams will be required to meet a minimum net alkalinity of zero.

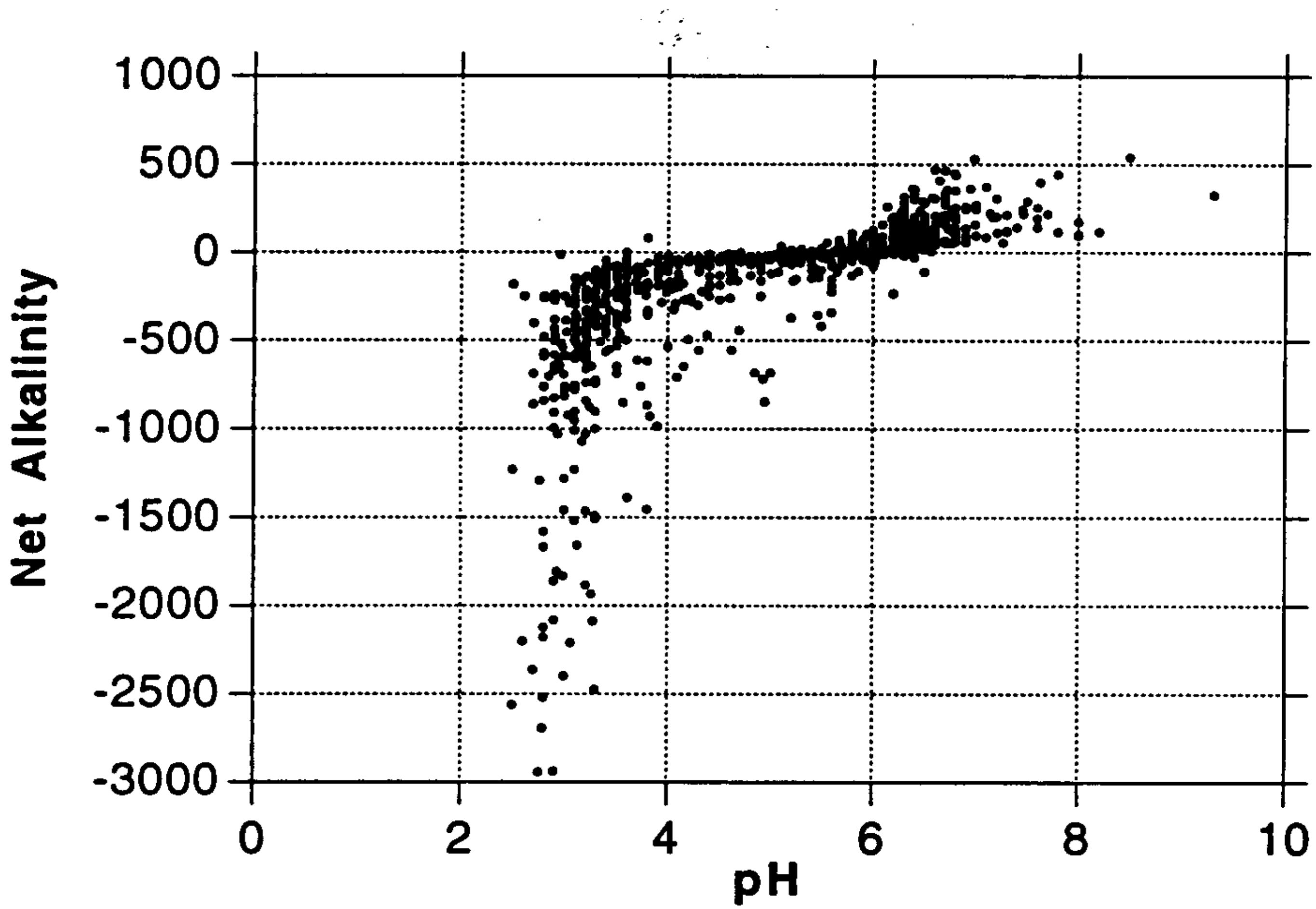


Figure 1.2, Graph C, net alkalinity vs. pH, page 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in PA

Attachment D

Example Calculation: Lorberry Creek

Example Calculation: Lorberry Creek

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

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

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

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

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

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

The calculations are detailed in the following section and Table 9 shows the allocations made on Lorberry Creek

1. A series of 4 equations were used to determine if a reduction was needed at point Swat-04, and, if so the magnitude of the reduction.

Table 1. Equations Used for Rowe Tunnel Analysis			
	Field Description	**Equation**	**Explanation**
1	Swat-04 initial Concentration Value (equation 1A)	= Risklognorm(mean,StDev)	This simulates the exisitng concentration of the sampled data.
2	Swat-04 % Reduction (from the 99^{th} percentile of PR)	= (input a percentage based on reduction target)	This is the percent reduction for the discharge.
3	Swat-04 Final Concentration Value	= Sampled Value x (1 - %reduction)	This applies the given percent reduction to the initial concentration.
4	Swat-04 Reduction Target (PR)	= maximum(0, 1- Cd/Cc)	This computes the necessary reduction, if needed, each time a value is sampled. The final reduction target is the 99^{th} percentile value of this computed field.

2. The reduction target (PR) was computed taking the 99th percentile value of 5000 iterations of the equation in row 4 of Table 9. The targeted percent reduction is shown, in boldface type, in the following table.

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

3. This PR value was then used as the % reduction in the equation in row 3. It was tested by checking that the water quality criterion for each metal was achieved at least 99% of the time. This is how the estimated percent reduction necessary for each metal was verified. The following table shows, in boldface type, the percent of the time criteria for each metal was achieved during 5000 iterations of the equation in row 3 of Table 9.

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

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

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

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

5. The following table shows variables used to express mass balance computations.

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

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

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

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

Q_{swat04} = RiskCumul(min,max,bin range,cumulative percent of occurrence)

The RiskCumul function takes 4 arguments: minimum value, maximum value, the bin range from the histogram, cumulative percent of occurrence)

The flow at Swat-11 was randomized using the equation developed by the regression analysis with point Swat-04.

$Q_{swat11} = Q_{swat}04 \times 0.142 + 0.088$

The mass balance equation is as follows:

$$Cstumps = ((Q_{swat04} * C_{swat04}) + (Q_{swat11} * C_{swat11}))/(Q_{swat04}+Q_{swat11})$$

This equation was simulated through 5000 iterations and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. The results show there is no further reduction needed for any of the metals at either point. The simulation results are shown in the following table.

Table 7. Verification of Meeting WQ Standards below Stumps Run			
Name	Below Stumps Run Aluminum	Below Stumps Run Iron	Below Stumps Run Manganese
Minimum =	0.0457	0.2181	0.1362
Maximum =	1.2918	1.7553	1.2751
Mean =	0.2505	0.6995	0.4404
Std Deviation =	0.1206	0.1970	0.1470
Variance =	0.0145	0.0388	0.0216
Skewness =	1.6043	0.8681	1.0371
Kurtosis =	7.7226	4.2879	4.8121
Errors Calculated =	0	0	0
WQ Criteria =	**0.75**	**1.5**	**1**
% of Time Criteria Achieved =	**99.52%**	**99.80%**	**99.64%**

4. The mass balance was then expanded to determine if any reductions would be necesssary at the L-1 (Shadle discharge).

   The L-1 discharge originated in 1997 and there are very little data available for it. The discharge will have to be treated or eliminated. It is the current site of a USGS test remediation project. The data that were available for the discharge were collected at a point prior to a settling pond. We currently do not have data for effluent from the settling pond.

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

Table 8 Shadle Adjusted BAT Concentrations				
Parameter	**Measured Value**		**BAT adjusted Value**	
	Average Conc.	Standard Deviation	Average Conc.	Standard Deviation
Iron	538.00	19.08	6.00	0.21
Manganese	33.93	2.14	4.00	0.25

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

   The same set of four equations used for point Swat-04 were set up for point L-1. The following equation was used for evaluation of point L-1.

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

This equation was simulated through 5000 iterations and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. It was estimated that an 81 % reduction in aluminum concentration is needed for point L-1.

The following table shows the simulation results of the equation above

Table 9. Verification of Meeting WQ Standards Below Point L-1

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

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

Table 10. Lorberry Creek

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

All values shown in this table are Long-Term Average Daily Values

The TMDL for Lorberry Creek requires that a load allocation is made to the Rowe Tunnel abandoned discharge for the three metals listed, and that a wasteload allocation is made to the L-1 discharge for aluminum. There is no TMDL for metals required for Stumps Run at this time.

Margin of safety

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

- None of the data sets were filtered by taking out extreme measurements. The 99% level of protection is designed to protect for the extreme event so we felt it pertinent not to filter the data set.

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

Attachment E

Data Used To Calculate the TMDL

Data Table 1. Two Mile Run, TM-4									
Date	Flow	Field pH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
7-Oct-99	58.0	4.5	3.8	0.0	94.0	94.0	0.46	10.30	12.00
23-Nov-99	51.1	4.5	3.6	0.0	138.0	138.0	0.84	15.50	18.60
16-Dec-99	1776.0	4.5	4.0	2.2	40.0	37.8	1.25	2.55	3.58
8-Mar-00	1731.0		3.9	0.0	48.0	48.0	1.36	2.68	6.18
13-Jul-00	347.0	4.5	3.9	0.0	46.0	46.0	0.58	2.90	5.28
12-Sep-00	210.0		3.7	0.0	76.0	76.0	1.03	7.04	9.03
Mean	695.52	4.5	3.8	0.37	73.67		0.92	6.83	9.11
StDev					37.72		0.36	5.25	5.52

Data Table 3. Robbins Hollow Run, RH-1									
Date	Flow	FieldpH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
7-Oct-99	10	4.5	3.8	0.0	130.0	130.0	0.16	13.60	16.60
23-Nov-99	8.5	4.0	3.8	0.0	162.0	162.0	0.13	18.40	24.50
16-Dec-99	*350*	4.5	3.8	0.0	58.0	58.0	0.57	4.96	5.95
8-Mar-00	*220*		3.9	0.0	44.0	44.0	0.38	3.81	5.40
13-Jul-00	*19.0*	4.5	3.8	0.0	60.0	60.0	0.17	5.94	7.09
12-Sep-00	*23.0*		3.8	0.0	90.0	90.0	0.20	10.80	11.60
Mean	121.50	4.38	3.82	0.00	90.67		0.27	9.58	11.86
Stand. Dev.					46.52		0.17	5.71	7.51

Data Table 4. Two Mile Run, TM-2									
Date	**Flow**	**FieldpH**	**LabpH**	**Alka**	**Acid**	**NetAcid**	**Iron**	**Mang**	**Alum**
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
7-Oct-99	150.0	4.5	3.9	0.0	78.0	78.0	0.13	9.50	9.27
23-Nov-99	136.5	4.5	3.8	0.0	92.0	92.0	0.22	11.90	12.40
16-Dec-99	4963.0	4.5	4.0	3.4	34.0	30.6	0.65	2.85	3.52
8-Mar-00	3296.0		4.0	2.8	38.0	35.2	0.65	2.62	4.73
13-Jul-00	454.0	4.5	3.9	0.0	50.0	50.0	0.22	4.40	6.52
12-Sep-00	264.0		3.8	0.0	58.0	58.0	0.14	7.30	7.21
Mean	1543.9	4.50	3.90	1.03	58.33		0.33	6.43	7.28
Stand. Dev.					22.78		0.25	3.78	3.21

Data Table 5. Huling Branch, HB-1									
Date	**Flow**	**FieldpH**	**LabpH**	**Alka**	**Acid**	**NetAcid**	**Iron**	**Mang**	**Alum**
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
7-Oct-99	200	4.6	3.2	0.0	166.0	166.0	14.60	9.44	12.30
23-Nov-99	139	4.5	3.1	0.0	210.0	210.0	19.90	12.20	16.60
16-Dec-99	3289	4.5	3.7	0.0	46.0	46.0	3.48	2.15	3.51
8-Mar-00	3098		3.7	0.0	48.0	48.0	3.23	1.99	4.64
13-Jul-00	603.0	4.5	3.4	0.0	86.0	86.0	5.61	3.98	7.35
12-Sep-00	529.0		3.1	0.0	160.0	160.0	13.00	8.19	11.70
Mean	1465.8	4.53	3.37	0.00	119.33		9.97	6.33	9.35
Stand. Dev.					68.74		6.87	4.23	5.04

Data Table 2. Middle Branch, MB-1									
Date	**Flow**	**FieldpH**	**LabpH**	**Alka**	**Acid**	**NetAcid**	**Iron**	**Mang**	**Alum**
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
26-Apr-1995	400.0		4.3	0	46.0	46.0	0.09	1.19	3.31
24-May-1995	1050.0		4.2	0	70.0	70.0	0.08	1.01	2.66
29-Jun-1995	331.5		4.1	0	48.0	48.0	0.10	1.56	4.22
17-Jul-1995	1.0		4.0	0	46.0	46.0	0.09	1.95	4.79
16-Aug-1995	1.0		4.0	0	50.0	50.0	0.13	2.41	5.47
13-Sep-1995	1.0		4.0	0	40.0	40.0	0.37	2.59	5.66
25-Oct-1995	265.0		4.1	0	38.0	38.0	0.09	2.02	4.90
13-Nov-1995	1135.0		4.1	0	30.0	30.0	0.10	1.38	3.98
18-Dec-1995	232.0		4.1	0	62.0	62.0	0.13	2.08	7.47
18-Jan-1996	367.0		4.2	0	48.0	48.0	0.46	1.80	5.19
13-Feb-1996	0.0		4.2	0	52.0	52.0	0.26	1.70	5.69
12-Mar-1996	0.0		4.1	0	38.0	38.0	0.47	1.25	4.39
9-Apr-1996	0.0		4.1	0	62.0	62.0	0.15	1.33	4.82
15-May-1996	777.1		4.1	0	30.0	30.0	0.20	0.90	2.80
18-Jun-1996	0.0		4.1	0	60.0	60.0	1.13	2.26	7.75
16-Jul-1996	0.0		4.2	0	46.0	46.0	0.56	2.31	6.25
12-Aug-1996	32.7		4.1	0	48.0	48.0	0.11	2.19	4.72
16-Sep-1996	438.0		4.0	0	48.0	48.0	0.34	0.12	5.77
29-Oct-1996	496.0		4.3	0	42.0	42.0	0.13	1.26	3.77
20-Nov-1996	419.0		4.3	0	46.0	46.0	0.15	1.45	4.57
17-Dec-1996	1503.0		4.3	0	32.0	32.0	0.26	0.92	3.09
13-Jan-1997	600.0		4.4	0	62.0	62.0	0.25	1.71	6.29
24-Feb-1997	2105.0		4.2	0	26.0	26.0	0.40	0.80	2.64
24-Mar-1997	477.0		4.3	0	42.0	42.0	0.17	1.08	3.65
14-Apr-	418.5		4.4	0	40.0	40.0	0.41	1.17	4.08

Data Table 2. Middle Branch, MB-1									
Date	**Flow**	**FieldpH**	**LabpH**	**Alka**	**Acid**	**NetAcid**	**Iron**	**Mang**	**Alum**
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1997									
12-May-1997	260.2		4.4	0	24.0	24.0	0.21	1.08	3.37
16-Jun-1997	141.9		4.3	0	40.0	40.0	0.08	1.23	3.11
28-Jul-1997	17.8		4.2	0	38.0	38.0	0.03	1.78	3.33
18-Aug-1997	1163.0			0	30.0	30.0	0.12	0.57	1.35
24-Sep-1997	70.2		4.2	0	66.0	66.0	0.41	3.56	10.90
21-Oct-1997	60.0		4.2	0	42.0	42.0	0.35	2.42	5.96
17-Nov-1997	476.5		4.4	0	36.0	36.0	0.11	1.27	3.53
15-Dec-1997	260.0		4.2	0	42.0	42.0	0.31	1.72	5.75
8-Jan-1998	1121.0		4.3	0	28	28.0	0.147	1.06	3.33
17-Feb-1998	920.0		4.3	0	32.0	32.0	0.20	1.30	4.60
17-Mar-1998	642.5		4.2	0	32.0	32.0	0.24	1.31	4.72
14-Apr-1998	1147.3		4.3	0	24.0	24.0	0.20	0.89	2.97
18-May-1998	777.0		4.2	0	30.0	30.0	0.20	1.06	3.37
8-Jun-1998	116.2		4.2	0	64.0	64.0	0.12	2.35	8.85
13-Jul-1998	92.3		4.2	0	50.0	50.0	0.05	2.14	6.08
11-Aug-1998	32.7		4.2	0	32.0	32.0	0.06	2.04	4.21
18-Nov-1998	6.3		4.5	0	22.0	22.0	0.42	1.81	3.14
7-Oct-99	*15.0*	4.5	4.4	6.8	20.0	13.2	0.02	1.81	2.79
23-Nov-99	*18.0*	4.5	4.3	6.0	40.0	34.0	0.01	3.37	5.64
16-Dec-99	1334.0	4.5	4.4	7.2	26.0	18.8	0.11	1.12	3.08
8-Mar-00	862.0		4.2	5.0	30.0	25.0	0.17	1.44	4.52
13-Jul-00	92.0	4.5	4.0	3.4	86.0	82.6	0.19	3.38	13.70
12-Sep-00	32.0		4.3	6.2	17.6	11.4	0.05	1.19	2.00
Mean	431.41	4.5	4.2	0.72	41.74		0.22	1.63	4.75

Data Table 2. Middle Branch, MB-1									
Date	Flow	FieldpH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Stand. Dev.					14.43		0.19	0.71	2.21

Data Table 6. Two Mile Run, TM-1A									
Date	Flow	FieldpH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
7-Oct-99	350.0	4.5	3.4	0.0	128.0	128.0	7.17	9.29	10.90
23-Nov-99	276.0	4.5	3.3	0.0	150.0	150.0	9.24	11.70	15.20
16-Dec-99	*8300.0*	4.5	3.9	0.0	40.0	40.0	1.86	2.37	3.32
8-Mar-00	*6394.0*		3.8	0.0	44.0	44.0	2.10	2.38	4.86
avg=	3830.00	4.50	3.60	0	90.50		5.09	6.43	8.57
stdev=				0	56.74		3.69	4.79	5.49

Data Table 7. Two Mile Run, TM-5A									
Date	Flow	FieldpH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
16-Dec-99	200.0	6.0	5.5	7.8	1.4	-6.4	0.04	0.02	0.10
8-Mar-00	299.0		5.8	8.0	0.4	-7.6	0.06	0.01	0.10
avg=	249.5	6.0	5.7	7.9	0.9		0.05	0.02	0.1

Data Table 8. Middle Branch, MB-5									
Date	Flow	FieldpH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
30-Nov-94			5.5	3.2	13.8	10.6	0.04	0.03	0.14

Data Table 9. Robbins Hollow Run, RH-3									
Date	Flow	FieldpH	LabpH	Alka	Acid	NetAcid	Iron	Mang	Alum
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
22-Jun-00		4.0	3.7	0.0	38.0	38.0	0.79	1.77	2.49
13-Jul-00	15.0	4.5	3.5	0.0	58.0	58.0	1.93	5.48	3.33
12-Sep-00	9.0		3.0	0.0	176.0	176.0	12.90	16.40	8.70
avg=	12.0	4.3	3.4	0.0	90.67		5.21	7.88	4.84

Data Table 10. Huling Branch, HB-12									
Date	**Flow**	**FieldpH**	**LabpH**	**Alka**	**Acid**	**NetAcid**	**Iron**	**Mang**	**Alum**
	(gpm)			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
16-Oct-80			5.7	12.0	13.0	1.0	0.10		
26-Nov-80			5.5	10.0	8.0	-2.0	1.00		
30-Dec-80			5.7	4.0	5.0	1.0	0.00		
24-Feb-81			5.3	13.0	6.0	-7.0	0.10		
24-Mar-81			5.8	6.0	7.0	1.0	0.00		
06-Apr-81			5.7	10.0	7.0	-3.0	0.00		
11-May-81			5.8	11.0	6.0	-5.0	0.50		
16-Jun-81			6.1	8.0	7.0	-1.0	0.00		
30-Jul-81			7.1	11.0	7.0	-4.0	0.50		
19-Aug-81			5.6	8.0	7.0	-1.0	0.00		
08-Sep-81			5.8	3.0	5.0	2.0	0.30		
15-Oct-81			5.7	12.0	4.0	-8.0	0.10		
25-Nov-81			5.8	6.0	7.0	1.0	0.00		
17-Feb-82			5.7	6.0	9.0	3.0	0.00		
17-Mar-82			5.1	8.0	4.0	-4.0	0.50		
20-May-82			5.5	4.0	18.0	14.0	0.00		
17-Jun-82			5.8	6.0	3.0	-3.0	0.10		
17-Aug-82			5.6	6.0	3.0	-3.0	0.00		
14-Sep-82			6.0	3.0	4.0	1.0	0.00		
29-Oct-82			5.7	4.0	4.0	0.0	0.10		
14-Dec-82			5.6	4.0	5.0	1.0	0.10		
03-Feb-83			5.8	2.0	3.0	1.0	0.00		
avg=			5.7	7.1	6.5		0.2		

Attachment F

Excerpts Justifying Changes Between the 1996, 1998, and Draft 2000 303(d) Lists

The following are excerpts from the Pennsylvania Department of Environmental Protection 303(d) narratives that justify changes in listings between the 1996, 1998, and draft 2000 list. The 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

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

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

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

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

The most notable difference between the 1998 and Draft 2000 303(d) lists are the listing of unnamed tributaries in 2000. In 1998, the GIS stream layer was coded to the named stream level so there was no way to identify the unnamed tributary records. As a result, the unnamed tributaries were listed as part of the first downstream named stream. The GIS stream coverage used to generate the 2000 list had the unnamed tributaries coded with DEP’s five-digit stream code. As a result, the unnamed tributary records are now split out as separate records on the 2000 303(d) list. This is the reason for the change in the appearance of the list and the noticeable increase in the number of pages.

Attachment G

Comment and Response

DEP received no official comments on this TMDL. Minor language edits may have been made since the draft document was public noticed.