HANS YOST CREEK WATERSHED TMDL

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INTRODUCTION

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Hans Yost Creek Watershed. It was done to address the impairments noted on the 1996 and 1998 Pennsylvania 305(b) report, required under the Clean Water Act, and covers three segments on the 1996 and 1998 303(d) lists (Table 1). The cause of these impairments is low pH with the source of the impairments being abandoned mine drainage (AMD). The TMDL addresses metals (iron, manganese, and aluminum) and low pH associated with AMD.

Table 1. Hans Yost Creek Watershed Segments Addressed

State Water Plan (SWP) 06-C: Mahantango Creek Watershed

Year	*Miles*	*Segment ID*	*DEP Stream Code*	*Stream Name*	*Designated Use*	*Data Source*	*EPA 305(b) Source Code*	*EPA 305(b) Cause Code*
1996	1	2200	17259	Hans Yost Creek	CWF	305(b) Report	RE	pH
1998	0.98	2200	17259	Hans Yost Creek	CWF	SWMP	AMD	pH
1998	2.38	970919-1500-MAF	17259	Hans Yost Creek	CWF	UP	AMD	pH Unknown
2000	1.01	2200	17259	Hans Yost Creek	CWF	SWMP	AMD	pH
2000	2.35	970919-1500-MAF	17259	Hans Yost Creek	CWF	UP	AMD	pH

CWF = Cold Water Fishes
RE = Resource Extraction
SWMP = Surface Water Monitoring Program
AMD = Abandoned Mine Drainage
UP = Unassessed Project

The “unknown” listing on the 1998 303(d) list was removed on the 2000 303(d) list. The data for all points indicated that there was impairment due to metals which the segments were not listed as being impaired by; therefore, the unknown listing is addressed in this TMDL by addressing three metals associated with abandoned mine drainage: iron, manganese, and aluminum.

Differences in mileage between segment listings for the same stream on the 1996, 1998, and 2000 303(d) lists are explained in Attachment A.

DIRECTIONS TO THE HANS YOST CREEK WATERSHED

Hans Yost Creek is a 3.51-square-mile watershed located in the Deep Creek Watershed in Schuylkill County, Pennsylvania (Attachment B). It is located approximately 39 miles northeast of Harrisburg, Pennsylvania, and approximately 4 miles north of the town of Tremont. It can be accessed by following U.S. Route 81 north from Harrisburg and exiting at the State Highway 901 exit.

SEGMENTS ADDRESSED IN THIS TMDL

There are few active mining operations in the watershed [Green Power Company, Inc. (Mining Permit #54920102), J&A Coal Company (Mining Permit #54880102), Snyder Coal (Mining Permit #54991302)]. However, these remining operations (Subchapter G) are not contributing to point-source pollution because they not created any new discharges and have not caused pre-existing discharges to worsen (Attachment C). Therefore, they will not be included in these TMDL analyses. All of the discharges in the watershed are from abandoned mining operations and will be treated as nonpoint sources. The distinction between point and nonpoint 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 nonpoint source. The TMDLs will be expressed as long-term, average loadings. Due to the nature and complexity of mining effects on the watershed, expressing the TMDL as a long-term average gives a better representation of the data used for the calculations.

The designation for these stream segments can be found in Pennsylvania Title 25, Chapter 93.9.

WATERSHED BACKGROUND

Hans Yost Creek is a 3.51-square-mile watershed located in the Deep Creek Watershed in Schuylkill County, Pennsylvania (Attachment B). It is located approximately 39 miles northeast of Harrisburg, Pennsylvania, and approximately 4 miles north of the town of Tremont. It drains part of a steep valley between Broad Mountain and Mahantango Mountain. The area was heavily mined through the late 19th and early 20th centuries. Hans Yost Creek flows through the Southern Anthracite Coalfield in eastern Pennsylvania. The anthracite coal region is characterized by deep, underground tunnel systems extending for miles. After the mine workings have been abandoned, the tunnels fill up with water and some discharge at the land surface. Many of these discharges are very large and are responsible for much of the water quality impairment in the region. There are active mining permits in the watershed; however, these are remining permits and have no discharge associated with them. All discharges that need allocations were abandoned before active remining began; therefore, the permit does not require an allocation as long as the discharges do not become worse during the course of remining activities (Attachment C).

The headwaters of Hans Yost Creek flow through heavily forested areas with little access. Although there are no tributaries shown on the Tremont quadrangle 7.5-minute series topographic map, there are small tributaries in the headwaters area that are intermittent. Hans Yost Creek is listed as impaired by low pH due to AMD. The source of the impairment(s) affecting this area is abandoned mine discharges. Two abandoned mine discharges flow into Hans Yost Creek, one near the headwaters area and one in its lower reaches. Both of these discharges are high gradient and adversely impact the stream. The first of the discharges, the Moser Mine Pool Discharge, enters Hans Yost Creek in the headwaters area. The other discharge, locally called Rattling Run, is the sum of at least two abandoned mine discharges (Collapsed Tunnel Discharge and Buck Mountain Vein Overflow Discharge). It drains into Hans Yost Creek in its lower reaches.

At least two studies have been conducted to assess the biological community present in Hans Yost Creek. In a 1972 Aquatic Biological Investigation of Hans Yost Creek by the Pennsylvania Department of Environmental Resources (Pa. DER), the macroinvertebrate community of Hans Yost Creek was found to be attaining water quality standards (Frey 1972). However, a 1997 investigation, conducted as part of the Pennsylvania Department of Environmental Protection's (Pa. DEP's) Unassessed Waters Program, found Hans Yost Creek to be impaired by low pH due to AMD.

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, all of the TMDL's component makeup will be load allocations that are specified above a point in the stream segment. All allocations will be specified as long-term average concentrations. These long-term average concentrations are expected to meet water quality criteria 99 percent of the time. Pennsylvania Title 25, Chapter 93.5(b) specifies that a minimum 99 percent level of protection is required. All metals criteria in these TMDLs are specified as total recoverable. Pennsylvania does have a dissolved criterion for iron. However, the data used for this analysis report iron as total recoverable. Table 2 shows the applicable water quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria			
Parameter	***Criterion value (mg/l)***	***Duration***	***Total Recoverable/ Dissolved***
Iron	1.50 0.3	1 day average Maximum	Total Recoverable Dissolved
Manganese	1.00	Maximum	Total Recoverable
Aluminum*	0.1 of the 96-hour LC-50 0.75	Maximum One hour	Total Recoverable
pH**	6-9	At all times	N/A

* These TMDLs were developed using the value of 0.75 mg/l as the instream criterion for aluminum. This is the U.S. Environmental Protection Agency (USEPA) 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 (the concentration of aluminum in test waters that is lethal to 50% of the test organisms during continuous exposure for 96 hours) and is contained in Pennsylvania Title 25, Chapter 93. The U.S. EPA national criterion was used because the Pa. DEP has recommended adopting the criterion and is awaiting its final promulgation.

** According to research conducted by the Pa. DEP, at pH = 6.0, the net alkalinity of a stream has been found to be zero (Attachment D). Therefore, the water quality standard for pH will vary, based on the instream alkalinity at that site with a minimum net alkalinity of zero being maintained. 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).

COMPUTATIONAL METHODOLOGY

Two approaches are used for the TMDL analysis of AMD-affected stream segments. Both of these approaches use the same statistical method for determining the instream allowable loading rate at the point of interest. The difference between the two is based on whether the pollution sources are defined as point or nonpoint source discharges. For the purposes of these analyses, point-source discharges are defined as discharges that are permitted or have a responsible party. Nonpoint sources are then any pollution sources that are not point-sources.

A TMDL equation consists of a wasteload allocation, load allocation, and a margin of safety. The wasteload allocation is the portion of the load assigned to point sources. The load allocation is the portion of the load assigned to nonpoint sources. The margin of safety is applied to account for uncertainties in the computational process. The margin of safety may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

Analysis of data for metals indicated that there was no single critical flow condition for pollutant sources, and further, that there was no significant correlation between source flows and pollutant concentrations. The following table shows the correlation coefficients for the Buck Mountain Discharge, the only sample point with greater than 10 samples with impaired flow/parameter data (Table 3).

Table 3. Correlation Coefficients for the Buck Mountain Discharge			
Flow vs.			***Number of Samples***
Iron	*Manganese*	*Aluminum*	
0.057	0.028	0.067	25

For situations where all of the impact is due to nonpoint sources, the equations shown below are applied using data for a point in the stream. The load allocation made at that point will be for all of the watershed area that is above that point. For situations where there are only point-source impacts or a combination of point and nonpoint sources, the evaluation will use the point-source data and perform a mass balance with the receiving water to determine the impact of the point-source.

TMDLs and load allocations for each pollutant were determined using Monte Carlo simulation; allocations were applied uniformly for the watershed area specified at each allocation point. For each source and pollutant, it was assumed that the observed data were log-normally distributed. Each pollutant source was evaluated separately using @Risk[1] by performing 5,000 iterations to determine any required percent reduction so that water quality criteria would be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

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

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

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

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

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

LTA = Mean * (1 – PR99) where (2)
LTA = allowable LTA source concentration in mg/l

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

Once the required percent reduction for each pollutant source was determined, a second series of Monte Carlo simulations were performed to determine if the cumulative loads from multiple sources allow instream water quality criteria to be met at all points at least 99 percent of the time. This second series of simulations combined the flows and loads from individual sources in a step-wise fashion, so that the level of attainment could be determined immediately downstream of each source. Where available data allowed, pollutant-source flows used were the average flows. Where data were insufficient to determine a source flow frequency distribution, the average flow derived from unit-area hydrology was used.

In general, these cumulative impact evaluations indicate that, if the percent reductions determined during the first step of the analysis are achieved, water quality criteria will be achieved at all upstream points, and no further reduction in source loadings is required.

Where a stream segment is listed on the 303(d) list for pH impairment, the evaluation is the same as that discussed above; the pH method is fully explained in Attachment D. Information for the TMDL analysis performed using the methodology described previously is contained in the TMDLs by segment section of this report. Unit-area hydrology calculations are presented in the hydrology section of this report. In addition, an example calculation from the Swatara Creek TMDL, including detailed tabular summaries of the Monte Carlo results, is presented for the Lorberry Creek TMDL in Attachment E.

HYDROLOGY

Data for points HY1 and HY2 did not include measurements of flow when they were taken. Flow determinations were made at HY2 using point HY3 as the basis for computing flow at this point in the upper section of the watershed. ArcView v3.2 was used to delineate the watersheds and determine watershed areas upstream of points HY2 and HY3. The flow at HY3 and the watershed areas upstream of HY2 and HY3 were used to compute the flow at HY2 using the following equation:

$$\frac{\text{Flow HY2}}{\text{Watershed Area HY2}} = \frac{\text{Flow HY3}}{\text{Watershed Area HY3}} \qquad (3)$$

The flow for point HY1 was determined using best professional judgment, based on the observation that the flow from the Moser Mine Pool Discharge made up approximately 50 percent of the total flow in Hans Yost Creek at their confluence. The flow calculated for point HY2 was multiplied by this percentage to determine the flow instream at point HY1. The remainder of the flow was allocated to the Moser Discharge.

Table 4. Flow Determination for Loading Points in Hans Yost Creek Watershed

Point Identification	*Average Flow (mgd*)*	*Determination Method*	*Number of Samples*	*Date Range*
HY1 (above Moser Discharge)	0.259	50% of HY2		
Moser Discharge	0.259	50% of HY2		
HY2 (below Moser Discharge)	0.518	Unit-area method		
HY3 (above Rattling Run)	1.49	Average of Available Flow Data	6	1992
Buck Mountain Discharge	0.168	Average of Available Flow Data	26	1992-1999
HY4 (below Rattling Run)	3.59	Average of Available Flow Data	6	1992

*mgd = million gallons per day

TMDLS BY SEGMENT

Hans Yost Creek Above HY1

Hans Yost Creek maintains low flows in the headwaters area of the watershed. No known abandoned mine discharges exist in this part of the watershed; however, very small seasonal tributaries carry water from the areas on the tops of the surrounding mountains into Hans Yost Creek during the spring. It is possible that a small, unknown discharge is polluting the upper reaches of Hans Yost Creek. The Moser Mine Pool Discharge flows into Hans Yost Creek immediately downstream of point HY1.

Aluminum and alkalinity data were not available for this segment of Hans Yost Creek; therefore, they were not evaluated in this TMDL. However, it is assumed that any best management practices (BMPs) used to reduce loads of iron and manganese would also cause reductions in aluminum loads. The TMDL for this segment of Hans Yost Creek consists of a load allocation to all of the watershed area above point HY1 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment.

Instream flow measurements were not available for point HY1. HY1 was not included as part of this TMDL, but reductions allocated at HY2 cover HY1 and the Moser Discharge.

Moser Mine Pool Discharge

The Moser Mine Pool Discharge is a high-gradient discharge, flowing from the mountain-side and falling in elevation until its confluence with Hans Yost Creek. The Tri-Valley Watershed Association has begun limestone dosing of this discharge to increase the alkalinity in the upper portions of the Hans Yost Creek Watershed.

Aluminum data were not available for the Moser Discharge; therefore, they were not evaluated in this TMDL. Again, BMPs used to reduce other metals would also reduce aluminum loads. The TMDL for the Moser Discharge consists of a load allocation to the Moser Discharge

(Attachment B). Addressing the mining impacts above this point addresses the impairment for the Moser Discharge.

Instream flow measurements were not available for the Moser Discharge. The Moser Discharge was not included as part of this TMDL, but reductions allocated at HY2 cover HY1 and the Moser Discharge.

Hans Yost Creek Between Points HY1 and HY2

Hans Yost Creek between points HY1 and HY2 receives the drainage of the Moser Mine Pool Discharge that is mixed with the water instream from above point HY1. Instream flow measurements were not available for point HY2. Since the discharge is above HY2, flow for this point was estimated using the unit-area hydrology method from a known point (HY3) on Hans Yost Creek (0.518 mgd).

Aluminum and alkalinity data were not available for this segment of Hans Yost Creek; therefore, they were not evaluated in this TMDL. Again, BMPs used to reduce other metals would also reduce aluminum loads. The TMDL for point HY2 consists of a load allocation to the area between point HY1 and HY2 (Attachment B). Addressing the mining impacts between these points addresses the impairment for the stream segment.

An allowable long-term average instream concentration for iron, manganese, and acidity was determined for point HY2. The analysis was designed to produce a long-term average value that, when met, would be protective of water quality criterion for that parameter 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents the long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point HY2 for the stream segment are shown in Table 5.

Table 5. Long-Term Average (LTA) Concentrations for Hans Yost Creek

HY2

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
HY2	Fe	1.05	4.5	0.31	1.3	71
	Mn	0.53	2.3	0.39	1.7	26
	Acidity	9.13	39.4	0	0	0

All values shown in this table are long-term average daily values.

The TMDL for Hans Yost Creek at point HY2 requires that a load allocation be made for all headwaters area of Hans Yost Creek for total iron and acidity.

Margin of Safety

For each TMDL calculated in this study, the margin of safety is applied implicitly. The allowable concentrations and loadings were simulated using Monte Carlo techniques and by employing the @Risk software.

Seasonal Variation

Seasonal variation is implicitly accounted for in each TMDL because the data represent a one-year period.

Critical Conditions

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

Hans Yost Creek Between Points HY2 and HY3

Hans Yost Creek between points HY2 and HY3 receives no additional mine drainage. Point HY3 is located immediately upstream of the confluence of Hans Yost Creek and Rattling Run. No tributaries drain into Hans Yost Creek between these two points. Loads of pollutants do increase within this segment of stream, however. This may be due to one of two reasons. First, it may be possible that an unknown discharge enters Hans Yost Creek in this reach. Second, it may be due to differences in the times at which data were collected. Data were used from various studies that collected data from monitoring points in Hans Yost Creek. If the collection points from various studies were located spatially close to one another, the data were combined together to form loading points (HY2, HY3, HY4). All data collected near that point were combined into one data set for that loading point. This allowed for more natural variation to be incorporated into the data set. However, this may cause loads to appear to increase without a source of pollutant. For example, if data were collected for the point HY2 during periods of low flow conditions and data for the point HY3 were collected during periods of high flow conditions, the loads for HY2 would be smaller than those for HY3 even though no additional sources of AMD come into the watershed between the two points. More study would be necessary to determine why the loads increase between the two points.

The TMDL for point HY3 consists of a load allocation to the area between loading points HY2 and HY3 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the stream segment between points HY2 and HY3.

Instream flow measurements were available for point HY3. Flow for this point was determined using the average flow from available data (1.49 mgd).

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined for point HY3. The analysis was designed to produce a long-term average value that, when met, would be protective of water quality criterion for that parameter 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents the long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point HY3 for the stream segment are shown in Table 6.

Table 6. Long-Term Average (LTA) Concentrations for Hans Yost Creek Between HY2 and HY3

Station	***Parameter***	***Measured Sample Data***		***Allowable***	
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
HY3	Fe	15.22	189.1	0.45	5.6
	Mn	1.78	22.1	0.28	3.5
	Al	2.07	25.7	0.23	2.9
	Acidity	5.62	69.8	0.28	3.5
	Alkalinity	1.80	22.4		

All values shown in this table are long-term average daily values.

The loading reductions for point HY2 were used to show the total load that was removed from upstream sources. The load reduction values were subtracted from the existing load at point HY3. This value was compared to the allowable load at point HY3. Reductions at point HY3 are necessary for any parameter that exceeded the allowable load at this point. Summaries of the loads that affect HY3 are shown in Table 7. Necessary reductions for HY3 are shown in Table 8.

Table 7. Summary of Loads Affecting HY3

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
HY2				
Existing Load	4.5	2.3	-	39.4
Allowable Load	1.3	1.7	-	0
Load Reduction	3.2	0.6	-	39.4

Table 8. Reductions for Hans Yost Creek Between HY2 and HY3

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***

Existing Loads at HY3	189.1	22.1	25.7	69.8
Total Load Reduction (HY2)	3.2	0.6	-	39.4
Remaining Load	185.9	21.5	25.7	30.4
Allowable Load at HY3	5.6	3.5	2.9	3.5
Percent Reduction	97	84	89	88

The TMDL for Hans Yost Creek at point HY3 requires that a load allocation be made for all areas between HY2 and HY3 for total iron, total manganese, total aluminum, and acidity.

Margin of Safety

For each TMDL calculated in this study, the margin of safety is applied implicitly. The allowable concentrations and loadings were simulated using Monte Carlo techniques and by employing the @Risk software.

Seasonal Variation

Seasonal variation is implicitly accounted for in each TMDL because the data represent a one-year period.

Critical Conditions

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

Buck Mountain Discharge

The Buck Mountain Discharge is a discharge from a stripping pit that forms the headwaters of Rattling Run, a high-gradient stream that flows into Hans Yost Creek. Rattling Run also drains discharge waters from a collapsed tunnel discharge; however, data are not available to allow allocations to be made to the collapsed tunnel.

The TMDL for the Buck Mountain Discharge consists of a load allocation to the Buck Mountain Discharge (Attachment B). Addressing the mining impacts for this discharge addresses the impairment.

Instream flow measurements were available for point HY3. Flow for this point was determined using the average flow from available data (0.168 mgd).

An allowable long-term average instream concentration was determined for the Buck Mountain Discharge for iron, manganese, aluminum, and acidity. The analysis was designed to produce a long-term average value that, when met, would be protective of water quality criterion for that parameter 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter.

For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents the long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at the Buck Mountain Discharge for the stream segment are shown in Table 9.

Table 9. Reductions for the Buck Mountain Discharge

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Buck Mt.	Fe	0.17	0.2	0.17	0.2	0
	Mn	0.27	0.4	0.27	0.4	0
	Al	1.66	2.3	0.35	0.5	79
	Acidity	21.24	29.8	0.85	1.2	96
	Alkalinity	1.72	2.4			

All values shown in this table are long-term average daily values.

The TMDL for the Buck Mountain Discharge requires that a load allocation be made for the discharge for total aluminum and acidity.

Margin of Safety

For each TMDL calculated in this study, the margin of safety is applied implicitly. The allowable concentrations and loadings were simulated using Monte Carlo techniques and by employing the @Risk software.

Seasonal Variation

Seasonal variation is implicitly accounted for in each TMDL because the data represent a one-year period.

Critical Conditions

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

Hans Yost Creek Between Points HY3 and HY4

Hans Yost Creek between points HY3 and HY4 includes the discharge from Rattling Run. Rattling Run is composed of discharge waters from at least two different abandoned mine discharges. These include the Buck Mountain Vein Overflow Discharge and the Collapsed

Tunnel Discharge. Point HY4 represents all points between HY3 and the mouth of Hans Yost Creek at its confluence with Deep Creek.

The TMDL for point HY4 consists of a load allocation to all of the area between points HY3 and HY4 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the stream segment between points HY3 and HY4.

Instream flow measurements were available for point HY4. Flow for this point was determined using the average from collected data (3.59 mgd).
Loads decrease between HY3 and HY4. This is most likely due to differences in when the data were collected between the various studies used to make up a data set for a loading point (see the narrative for the areas between HY2 and HY3 for a more detailed explanation). It also may be due to instream processes (precipitation of metals onto the stream bed) that may be causing the concentration of pollutants and therefore the load to be smaller at HY4 than at HY3.

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined for point HY4. The analysis was designed to produce a long-term average value that, when met, would be protective of water quality criterion for that parameter 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compared against the water quality criterion for that parameter. For each sampling event, a percent reduction was calculated, if necessary, to meet water quality criteria. A second simulation that multiplied the percent reduction times the sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents the long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations for point HY4 are shown in Table 10.

Table 10. Long-Term Average (LTA) Concentrations for Hans Yost Creek Between HY3 and HY4

Station	***Parameter***	***Measured Sample Data***		***Allowable***	
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
HY4	Fe	2.68	80.2	0.35	10.5
	Mn	1.05	31.4	0.16	4.8
	Al	3.77	112.9	0.15	4.5
	Acidity	12.05	360.8	4.74	141.9
	Alkalinity	8.87	265.6		

All values shown in this table are long-term average daily values.

The loading reductions for point HY3 and the Buck Mountain Discharge were used to show the total load that was removed from upstream sources. The load reduction values were subtracted from the existing load at point HY4. This value was compared to the allowable load at point HY4. Reductions at point HY4 are necessary for any parameter that exceeded the allowable load at this point. A summary of the loads that affect HY4 is shown in Table 11. Necessary reductions for HY4 are shown in Table 12.

Table 11. Summary of Loads Affecting HY4

	Iron (lb/day)	*Manganese (lb/day)*	*Aluminum (lb/day)*	*Acidity (lb/day)*
HY3				
Existing Load	189.1	22.1	25.7	69.8
Allowable Load	5.6	3.5	2.9	3.5
Load Reduction	183.5	18.6	22.8	66.3
Buck Mt.				
Existing Load	0.2	0.4	2.3	29.8
Allowable Load	0.2	0.4	0.5	1.2
Load Reduction	0	0	1.8	28.6

Table 12. Reductions for Hans Yost Creek Between HY3 and HY4

	Iron (lb/day)	*Manganese (lb/day)*	*Aluminum (lb/day)*	*Acidity (lb/day)*
Existing Loads at HY4	80.2	31.4	112.9	360.8
Total Load Reduction (HY3, Buck Mt.)	183.5	18.6	24.6	94.9
Remaining Load	0	12.8	88.3	265.9
Allowable Load at HY4	10.5	4.8	4.5	141.9
Percent Reduction	0	63	95	47

The TMDL for Hans Yost Creek at point HY4 requires that a load allocation be made to all areas between HY3 and HY4 for total manganese, total aluminum, and acidity.

Margin of Safety

For each TMDL calculated in this study, the margin of safety is applied implicitly. The allowable concentrations and loadings were simulated using Monte Carlo techniques and by employing the @Risk software.

Seasonal Variation

Seasonal variation is implicitly accounted for in each TMDL because the data represent a one-year period and account for all seasons.

Critical Conditions

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

SUMMARY OF ALLOCATIONS

This TMDL will focus remediation efforts on the identified numerical reduction targets for each segment. As changes occur in the watershed, the TMDL may be re-evaluated to reflect current conditions. Table 13 represents the estimated reductions identified for all points in the watershed.

Table 13. Summary Table – Hans Yost Creek Watershed

Station	*Parameter*	*Measured Sample Data*		*Allowable*		*Reduction Identified*
		Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
HY2	Fe	1.05	4.5	0.31	1.3	71
	Mn	0.53	2.3	0.39	1.7	26
	Al	No data available.				-
	Acid	9.13	39.4	0	0	100
	Alkalinity	No data available.				
	Instream monitoring point located at HY2					
HY3	Fe	15.22	189.1	0.45	5.6	97
	Mn	1.78	22.1	0.28	3.5	84
	Al	2.07	25.7	0.23	2.9	89
	Acid	5.62	69.8	0.28	3.5	88
	Alkalinity	1.80	22.4			
	Monitoring point located at the Buck Mountain Discharge					
Buck Mt.	Fe	0.17	0.2	0.17	0.2	0
	Mn	0.27	0.4	0.27	0.4	0
	Al	1.66	2.3	0.35	0.5	79
	Acid	21.24	29.8	0.85	1.2	96
	Alkalinity	1.72	2.4			
	Instream monitoring point located at HY3					
HY4	Fe	2.68	80.2	0.35	10.5	0
	Mn	1.05	31.4	0.16	4.8	63
	Al	3.77	112.9	0.15	4.5	95
	Acid	12.05	360.8	4.74	141.9	47
	Alkalinity	8.87	265.6			

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

RECOMMENDATIONS

The Tri-Valley Watershed Association is a local watershed group operating in the Deep Creek, Pine Creek, and Mahantango Creek Watersheds. The group is currently receiving assistance from the Schuylkill County Conservation District, the Pottsville District Mining Office of the Pa. DEP, and the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR). The group received a small grant from EPCAMR to treat the Moser Mine Pool Discharge with limestone and began dosing during the summer of 2000. They also plan to develop a comprehensive watershed monitoring and remediation plan and apply for a Growing Greener Grant.

PUBLIC PARTICIPATION

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and in local newspapers on December 16, 2000, to foster public comment on the allowable loads calculated. A public meeting will be held on January 9, 2001, at the Hegins Valley Water Authority in Valley View, Pa., to discuss the proposed TMDL.

REFERENCES

Frey, Robert F. 1972. Aquatic Biological Investigation, Hans Yost Creek, Schuylkill County, June 1, 1972, Mine Drainage. Memo to George L. Parks, Acting Chief, Operations Section, Pennsylvania Department of Environmental Resources, West Reading Office, August 8, 1972.

Rhodes, Ralph L. and Robert S. Davis. 1968. Mine Drainage in the Susquehanna River Basin. U.S. Department of the Interior, Federal Water Pollution Control Administration, Middle Atlantic Region, Charlottesville, Virginia.

Skelly & Loy. 1973. Coal Mine Drainage in the Susquehanna River Basin. Report prepared for the Susquehanna River Basin Commission by Skelly & Loy, Engineers – Consultants, Harrisburg, Pa., September 1973.

Attachment A

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

The following are excerpts from the Pennsylvania Department of Environmental Protection (DEP) 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:

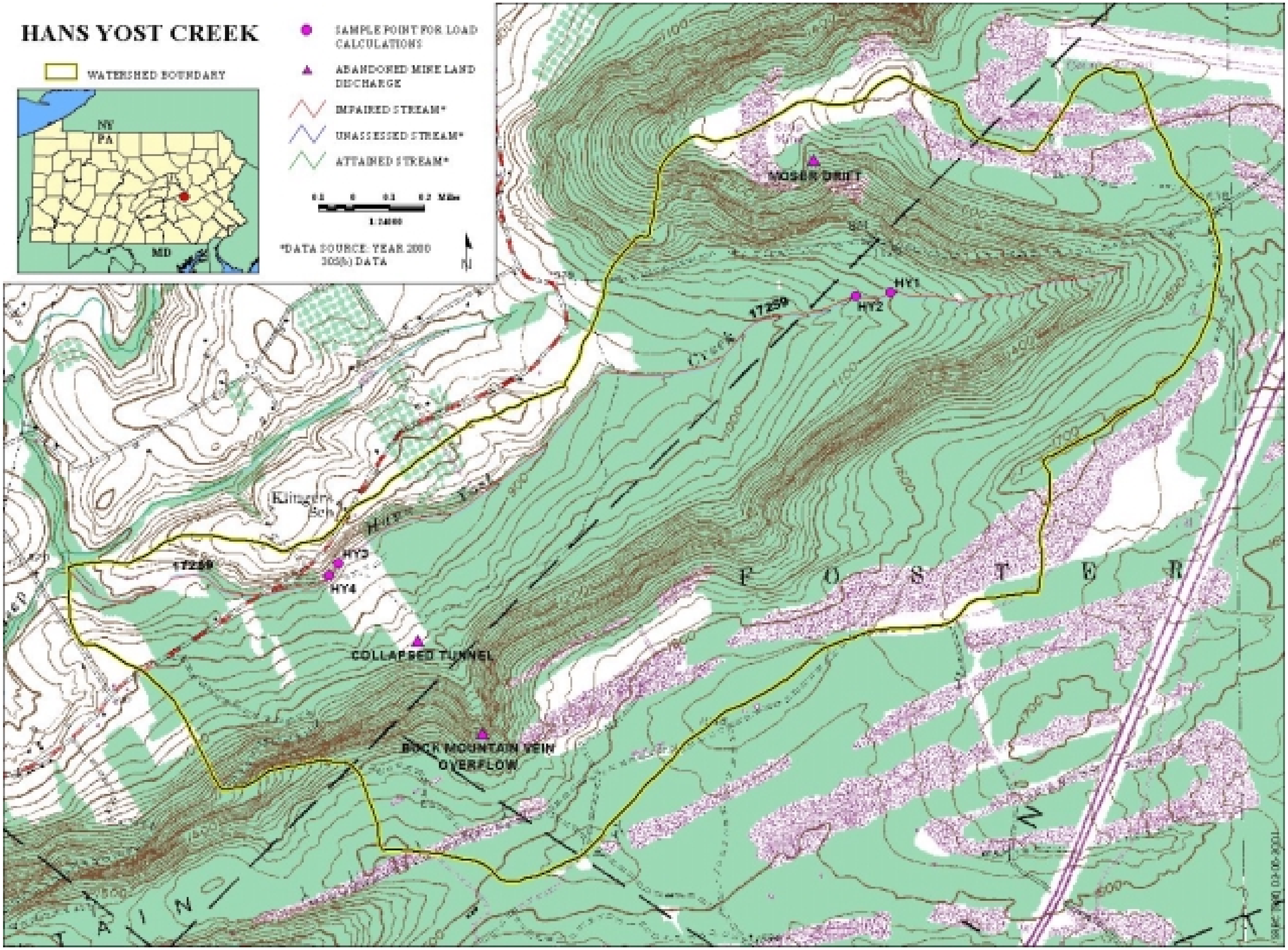
1. mileage differences due to recalculation of segment length by the GIS;
2. slight changes in source(s)/cause(s) due to new EPA codes;
3. changes to source(s)/cause(s), and/or miles due to revised assessments;
4. corrections of misnamed streams or streams placed in inappropriate SWP subbasins; and
5.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

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

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 the 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 B

Hans Yost Creek Watershed Map


HANS YOST CREEK
WATERSHED BOUNDARY
NY
PA
MD
SAMPLE POINT FOR LOAD CALCULATIONS
ABANDONED MINE LAND DISCHARGE
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
0.1 0 0.1 0.2 Miles
1:24000
*DATA SOURCE: YEAR 2000 305(b) DATA
N
MOSER DRIFT
HY1
HY2
17259
Creek
HY3
HY4
17259
COLLAPSED TUNNEL
BUCK MOUNTAIN VEIN OVERFLOW
F O S T E R

Attachment C

Subchapter G Mining

TMDLs and Remining Activities in Pennsylvania

This attachment provides an overview and history of the remining requirements as related to NPDES permitting and TMDLs. Described in the following text is an overview of the regulations and incentives that pertain to the water quality aspect of the current remining programs in Pennsylvania.

Acid drainage from abandoned underground and surface coal mines and coal refuse piles is a large problem in the Appalachian Coal Region of the Eastern United States. Prior to the passage of the federal Surface Mining Control and Reclamation Act (SMCRA) in 1977, reclamation of mining sites was not a federal requirement and therefore, was not often done. One of SMCRA's goals was to promote the reclamation of mined areas left without adequate reclamation prior to the enactment of SMCRA and which continue, in their unreclaimed condition, to substantially degrade the quality of the environment; damage the beneficial use of land or water resources; or endanger the health or safety of the public.

In 1982, the U.S. Environmental Protection Agency promulgated final effluent limit guidelines under the Clean Water Act to limit the discharges from the coal mining industry point-source category. The rule amended previously promulgated effluent limit guidelines based on "best practicable control technology" (BPT) and "new source performance standards" (NSPS), and established new guidelines based on "best available technology economically achievable" (BAT). The issue of remining was raised during the comment period following the 1982 proposal of the final rule. Comments addressed the fact that technology-based standards would likely serve as a deterrent to remining activities, since the operator would have to assume responsibility for treating effluent from previous operations that already may be significantly contaminated. This was not addressed in the final rule, and EPA stated that generally, the effluent limitations guidelines are applicable to all point source discharges even if those discharges pre-dated the remining operation.

In 1987, the "Rahall Amendment" to the Clean Water Act was passed, and provided incentives for remining abandoned mine lands that were mined prior to the 1977 passage of SMCRA. The amendment established that BAT effluent limitations for iron, manganese and pH are not required for discharges that existed prior to remining activities. Instead, site-specific BAT limits, determined by best professional judgment (BPJ) are applicable to these pre-existing discharges, and the permit effluent limits for iron, manganese, and pH (acidity) may not exceed pre-existing baseline levels. Prior to the federal law changes in 1987, the Pennsylvania (Pa.) legislature amended Pa. SMCRA in 1984 to include remining incentives. Under the Pa. law and related regulations [25 Pa. Code 87, Subchapter F (bituminous coal) and Chapter 88 (anthracite coal)], a baseline pollution load is established; a pollution abatement plan is submitted incorporating best technology; and the effluent limits for the pre-existing discharges are determined by the BPJ process.

Pennsylvania has issued over 260 remining permits dating back to 1985 and continues to do so. For the purpose of TMDL development in watersheds where remining operations are occurring, the pre-existing discharges associated with the remining activity will not be given wasteload allocations. These loads will be accounted for in the TMDL as part of the overall load allocation. This is consistent with the Clean Water Act and Pa. regulations, since the current operator is not responsible for cleanup and remediation of these pre-existing discharges.

Literature Cited: U.S. EPA. 2000. Draft Coal Remining – Best Management Practices Guidance Manual. Report No. EPA-821-R-00-007. U.S. EPA, Washington, D.C.

Attachment D

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 by the Pa. Department of Environmental Protection demonstrates that by plotting net alkalinity (alkalinity-acidity) versus pH for 794 mine sample points, the resulting pH value from a sample possessing a net alkalinity of zero is approximately equal to 6 (Figure 1). Where net alkalinity is positive (greater than or equal to zero), the pH range is most commonly 6 to 8, which is within the USEPA's acceptable range of 6 to 9 and meets Pennsylvania water quality criteria in Chapter 93.

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

Each sample point used in the analysis of pH by this method must have measurements for total alkalinity and total acidity. Net alkalinity is alkalinity minus acidity, both being in units of milligrams per liter (mg/l) $CaCO_3$. The same statistical procedures that have been described for use in the evaluation of the metals is applied, using the average value for total alkalinity at that point as the target to specify a reduction in the acid concentration. By maintaining a net alkaline stream, the pH value will be in the range between 6 and 8. This method negates the need to specifically compute the pH value, which for mine waters is not a true reflection of acidity. This method assures that Pennsylvania's standard for pH is met when the acid concentration reduction is met.

There are several documented cases of streams in Pennsylvania having a natural background pH below 6. 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. Summarized, 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 percent confidence level will be applied. The pH range will be varied only for streams in which a natural unaffected net alkalinity level can be established. This can only be done for streams that have upper segments that are not impacted by mining activity. All other streams will be required to meet a minimum net alkalinity of zero.

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

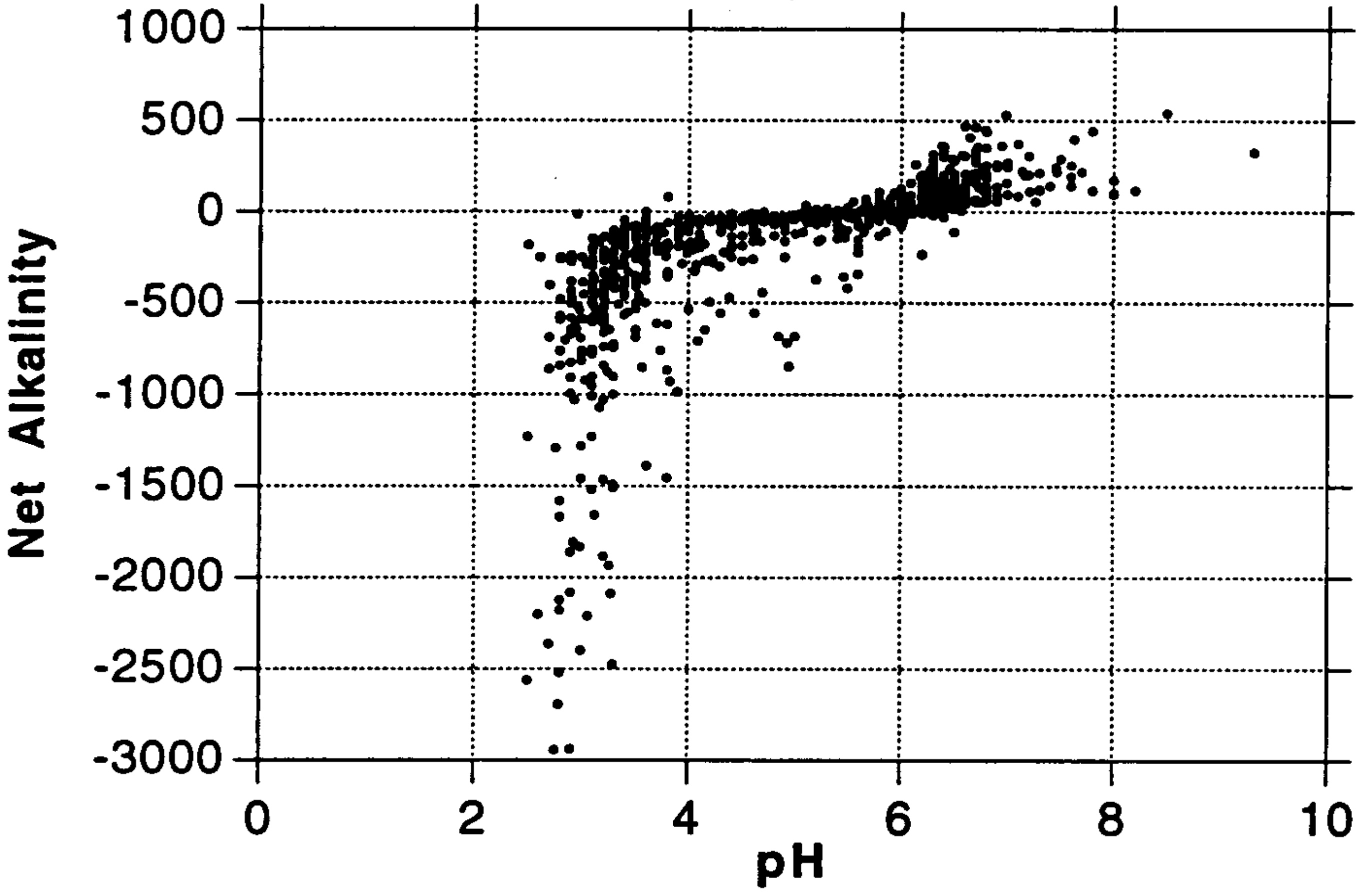


Figure 1: Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

Attachment E

Example Calculation: Lorberry Creek

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

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

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

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

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

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

The calculations are detailed in the following section (Tables 1-8). Table 9 shows the allocations made on Lorberry Creek.

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

Table 1. Equations Used for Rowe Tunnel Analysis (SWAT 04)

	Field Description	Equation	Explanation
1	Swat-04 Initial Concentration Value (Equation 1A)	= Risklognorm (Mean, St Dev)	This simulates the existing concentration of the sampled data.
2	Swat-04 % Reduction (from the 99th percentile of percent reduction)	= (Input a percentage based on reduction target)	This is the percent reduction for the discharge.
3	Swat-04 Final Concentration Value	= Sampled Value x (1-percent reduction)	This applies the given percent reduction to the initial concentration.
4	Swat-04 Reduction Target (PR)	= Maximum (0, 1- Cd/Cc)	This computes the necessary reduction, if needed, each time a value is sampled. The final reduction target is the 99th percentile value of this computed field.

2. The reduction target (PR) was computed taking the 99th percentile value of 5,000 iterations of the equation in row four of Table 1. The targeted percent reduction is shown, in boldface type, in the following table.

Table 2. Swat-04 Estimated Target Reductions

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

3. This PR value was used as the percent reduction in the equation in row three of Table 1. Testing was done to see that the water quality criterion for each metal was achieved at least 99 percent of the time. This verified the estimated percent reduction necessary for each metal. Table 3 shows, in boldface type, the percent of the time criteria for each metal was achieved during 5,000 iterations of the equation in row three of Table 1.

Table 3. Swat-04 Verification of Target Reductions

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

4. These same four equations were applied to point Swat-11. The result was that no reduction was needed for any of the metals. Tables 4 and 5 show the reduction targets computed for, and the verification of, reduction targets for Swat-11.

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

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

5. Table 6 shows variables used to express mass balance computations.

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

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

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

The flow from Swat-04 (Q_{swat04}) was set into an @RISK function so it could be used to simulate loading into the stream. The cumulative probability function was used for this random flow selection. The flow at Swat-04 is as follows (Equation 1):

$$Q_{swat04} = \text{RiskCumul(min,max,bin range,cumulative percent of occurrence)} \qquad (1)$$

The RiskCumul function takes four arguments: minimum value, maximum value, the bin range from the histogram, and cumulative percent of occurrence.

The flow at Swat-11 was randomized using the equation developed through the regression analysis with point Swat-04 (Equation 2).

$$Q_{swat11} = Q_{swat}04 \text{ x } 0.142 + 0.088 \qquad (2)$$

The mass balance equation is as follows (Equation 3):

$$C_{stumps} = ((Q_{swat04} * C_{swat04}) + (Q_{swat11} * C_{swat11}))/(Q_{swat04}+Q_{swat11}) \qquad (3)$$

This equation was simulated through 5,000 iterations, and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. The results show there is no further reduction needed for any of the metals at either point. The simulation results are shown on Table 7.

Table 7. Verification of Meeting Water Quality Standards Below Stumps Run

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

7. The mass balance was expanded to determine if any reductions would be necessary at point L-1.

The Shadle Discharge originated in 1997, and very few data are available for it. The discharge will have to be treated or eliminated. It is the current site of a USGS test remediation project. The data that were available for the discharge were collected at a point prior to a settling pond. Currently, no data for effluent from the settling pond are available.

Modeling for iron and manganese started with the BAT-required concentration value. The current effluent variability based on limited sampling was kept at its present level. There was no BAT value for aluminum, so the starting concentration for the modeling was arbitrary. The BAT values for iron and manganese are 6 mg/l and 4 mg/l, respectively. Table 8 shows the BAT-adjusted values used for point L-1.

Table 8. L-1 Adjusted BAT Concentrations

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

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

The same set of four equations used for point Swat-04 was used for point L-1. The equation used for evaluation of point L-1 is as follows (Equation 4):

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

This equation was simulated through 5,000 iterations, and the 99th percentile value of the data set was compared to the water quality criteria to determine if standards had been met. It was estimated that an 81 percent reduction in aluminum concentration was needed for point L-1.

8. Table 9 shows the simulation results of the equation above.

Table 9. Verification of Meeting Water Quality Standards Below Point L-1			
Name	**Below L-1 Aluminum**	**Below L-1 Iron**	**Below L-1 Manganese**
Minimum =	0.0815	0.2711	0.1520
Maximum =	1.3189	2.2305	1.3689
Mean =	0.3369	0.7715	0.4888
Std Deviation =	0.1320	0.1978	0.1474
Variance =	0.0174	0.0391	0.0217
Skewness =	1.2259	0.8430	0.9635
Kurtosis =	5.8475	4.6019	4.7039
Errors Calculated =	0	0	0
WQ Criteria=	**0.75**	**1.5**	**1**
Percent of time achieved=	**99.02**	**99.68**	**99.48**

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

Table 10. Lorberry Creek Summary Table						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
Swat 04						
	Al	1.01	21.45	0.27	5.79	73%
	Fe	8.55	181.45	0.77	16.33	91%
	Mn	2.12	44.95	0.49	10.34	77%
Swat 11						
	Al	0.08	0.24	0.08	0.24	0%
	Fe	0.18	0.51	0.18	0.51	00%
	Mn	0.09	0.27	0.09	0.27	00%
L-1						
	Al	34.90	9.03	6.63	1.71	81%
	Fe	6.00	1.55	6.00	1.55	0%
	Mn	4.00	1.03	4.00	1.03	0%

All values shown in this table are long-term average daily values

The TMDL for Lorberry Creek requires that a load allocation be made to the Rowe Tunnel Discharge (Swat-04) for the three metals listed, and that a wasteload allocation is made to the Shadle Discharge (L-1) for aluminum. There is no TMDL for metals required for Stumps Run (Swat-11) at this time.

Margin of safety

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

- None of the data sets were filtered by taking out extreme measurements. Because the 99 percent level of protection is designed to protect for the extreme event, it was pertinent not to filter the data set.

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

Attachment F

Data Used To Calculate the TMDLs

TMDL Site	Site Location	Company	Permit #	Date	Discharge	Acidity	Alkalinity	Iron	Manganese	Aluminum
HY 01	Upstream HansYost	J & A Coal Co.	54880102	10/14/88	*	6.5	*	*	<0.03	*
	Upstream HansYost	J & A Coal Co.	54880102	12/21/88	*	0.8	*	0.07	<0.03	*
	Upstream HansYost	J & A Coal Co.	54880102	1/31/89	*	6.1	*	1.12	0.16	*
	Upstream HansYost	J & A Coal Co.	54880102	11/4/88	*	8.7	*	0.08	0.92	*
	Upstream HansYost	J & A Coal Co.	54880102	4/29/96	*	9.9	*	0.85	0.62	*
	Upstream HansYost	J & A Coal Co.	54880102	5/2/96	*	15.3	*	0.7	0.45	*
				Average =		7.88		0.56	0.54	
				StDev =		4.80		0.47	0.32	
HY 02	Downstream Hans Yost	J & A Coal Co.	54880102	10/14/88	*	8.5	*		0.71	*
	Downstream Hans Yost	J & A Coal Co.	54880102	12/21/88	*	8.5	*	<0.04	0.53	*
	Downstream Hans Yost	J & A Coal Co.	54880102	1/31/89	*	4.9	*	1.11	0.16	*
	Downstream Hans Yost	J & A Coal Co.	54880102	11/4/88	*	7.7	*	0.09	0.87	*
	Downstream Hans Yost	J & A Coal Co.	54880102	4/29/96	*	9.9	*	2.3	0.45	*
	Downstream Hans Yost	J & A Coal Co.	54880102	5/2/96	*	15.3	*	0.7	0.48	*
				Average =		9.13		1.05	0.53	
				StDev =		3.45		0.93	0.24	
Moser	Moser Drift (Tunnel)	J & A Coal Co.	54880102	10/14/88	*	10.9	*	*	0.82	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	12/21/88	*	9.6	*	<0.04	0.8	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	1/31/89	*	8.4	*	1.14	0.17	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	7/27/90	*	9.2	*	1.1	1.02	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	8/17/90	*	12.6	*	0.9	0.71	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	9/29/90	*	<1	*	1.8	0.92	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	10/5/90	*	11.4	*	1.18	0.92	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	11/28/90	*	13.3	*	2	0.97	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	12/31/90	*	5.7	*	0.72	0.55	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	1/31/91	*	12.8	*	1.65	0.88	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	2/28/91	*	10.7	*	1.3	0.8	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	3/29/91	*	9.2	*	0.23	0.57	*

TMDL Site	Site Location	Company	Permit #	Date	Discharge	Acidity	Alkalinity	Iron	Manganese	Aluminum
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	4/30/91	*	14	*	1.3	0.78	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	5/30/91	*	11	*	1.75	0.85	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	6/14/91	*	11.6	*	2	0.81	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	7/23/91	*	13	*	4	0.92	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	8/21/91	*	7.4	*	3.5	0.92	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	9/25/91	*	26	*	3.9	0.85	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	10/23/91	*	17	*	3.6	0.96	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	11/13/91	*	4.2	21.9	1	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	12/13/91	*	1.2	30	0.95	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	1/24/92	*	1.57	22	0.94	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	2/25/92	*	1.56	17	1.2	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	3/27/92	*	2.7	1.2	1	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	4/29/92	*	1.35	17	0.71	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	5/21/92	*	2.15	15	0.9	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	6/3/92	*	1.88	21	0.93	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	7/31/92	*	1.85	16	1	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	8/24/92	*	2.7	26	1	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	10/2/92	*	2.75	22	0.98	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	11/24/92	*	1.6	20.8	0.86	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	12/17/92	*	2.4	17.1	1	*	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	1/29/93	*	14	*	1.65	0.85	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	2/26/93	*	5.1	*	0.08	0.09	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	3/25/93	*	20	*	2	0.83	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	6/30/94	*	63	*	1.25	0.75	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	9/30/94	*	7	*	1.6	0.83	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	12/30/94	*	20.9	*	1.5	0.78	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	3/22/95	*	16.8	*	1.3	0.75	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	6/30/95	*	26.8	*	2.8	0.9	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	9/26/95	*	9.5	*	3.5	0.75	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	12/18/95	*	17.3	*	1.4	0.72	*
	Moser Drift (Tunnel)	J & A Coal Co.	54880102	9/30/98	*	3.8	*	1.5	0.74	*
				Average =		10.62	19.00	1.54	0.77	
				StDev =		10.69	6.81	0.95	0.20	

TMDL Site	Site Location	Company	Permit #	Date	Discharge	Acidity	Alkalinity	Iron	Manganese	Aluminum
HY 03	Upstream HansYost	Green Power Inc.	54920102	3/3/92	1200	2	1	11.2	2.3	1.4
	Upstream HansYost	Green Power Inc.	54920102	4/6/92	875	12.7	2.3	0.4	0.28	0.7
	Upstream HansYost	Green Power Inc.	54920102	5/9/92	1450	2	3	23.8	2.7	2.3
	Upstream HansYost	Green Power Inc.	54920102	6/4/92	750	14	1	14.6	2.3	4.2
	Upstream HansYost	Green Power Inc.	54920102	7/9/92	900	2	1.4	23.8	2.7	2.3
	Upstream HansYost	Green Power Inc.	54920102	8/12/92	1020	1	2.1	17.5	0.37	1.5
				Average =	1032.50	5.62	1.80	15.22	1.78	2.07
				StDev =	254.83	6.02	0.80	8.82	1.14	1.21
HY 04	Downstream Hans Yost	Green Power Inc.	54920102	3/27/92	3200	18.3	4.7	3.1	3.5	5.3
	Downstream Hans Yost	Green Power Inc.	54920102	4/9/92	2400	11.3	9.2	0.5	0.52	0.7
	Downstream Hans Yost	Green Power Inc.	54920102	5/6/92	1885	12.7	8.7	0.4	0.28	0.7
	Downstream Hans Yost	Green Power Inc.	54920102	6/4/92	3500	10.3	12.6	3.5	0.4	10
	Downstream Hans Yost	Green Power Inc.	54920102	7/8/92	2100	9	11.7	6.2	1.65	3.2
	Downstream Hans Yost	Green Power Inc.	54920102	8/6/92	1850	10.7	6.3	2.4	0.28	2.7
				Average =	2489.17	12.05	8.87	2.68	1.11	3.77
				StDev =	701.43	3.29	3.03	2.16	1.28	3.51
Buck Mt.	Buck Mountain Overflow	Green Power Inc.	54920102	3/3/92	162	28	1	0.09	0.3	2.8
	Buck Mountain Overflow	Green Power Inc.	54920102	4/10/92	100	23	1	0.75	0.4	3.5
	Buck Mountain Overflow	Green Power Inc.	54920102	5/6/92	112	25	1	0.04	0.21	2.1
	Buck Mountain Overflow	Green Power Inc.	54920102	6/9/92	215	11.3	2.2	0.5	0.3	0.7
	Buck Mountain Overflow	Green Power Inc.	54920102	7/8/92	75	22	1	0.15	0.2	2.4
	Buck Mountain Overflow	Green Power Inc.	54920102	8/12/92	60	32	10	0.1	0.26	1.7
	Buck Mountain Overflow	Green Power Inc.	54920102	1/25/95	150	21.6	1	0.04	0.25	1.2
	Buck Mountain Overflow	Green Power Inc.	54920102	2/22/95	108	31.2	1	0.04	0.3	1.3
	Buck Mountain Overflow	Green Power Inc.	54920102	3/30/95	108	20.9	1	0.08	0.29	1.5
	Buck Mountain Overflow	Green Power Inc.	54920102	4/28/95	70.2	20.9	1	0.07	0.29	1.6
	Buck Mountain Overflow	Green Power Inc.	54920102	5/28/95	108	23.8	1	0.09	0.27	1.6
	Buck Mountain Overflow	Green Power Inc.	54920102	6/28/95	70.2	24.7	1	0.04	0.23	1.4
	Buck Mountain Overflow	Green Power Inc.	54920102	7/31/95	70.2	19	1	0.07	0.3	1.4

TMDL Site	Site Location	Company	Permit #	Date	Discharge	Acidity	Alkalinity	Iron	Manganese	Aluminum
	Buck Mountain Overflow	Green Power Inc.	54920102	9/30/95	13.4	19.8	1	0.9	0.29	1.8
	Buck Mountain Overflow	Green Power Inc.	54920102	1/23/99	197	12.6	1.4	0.04	0.21	1.3
	Buck Mountain Overflow	Green Power Inc.	54920102	2/21/99	248	13.4	2.3	0.04	0.23	1.5
	Buck Mountain Overflow	Green Power Inc.	54920102	3/19/99	197	12.8	1.8	0.06	0.25	1.2
	Buck Mountain Overflow	Green Power Inc.	54920102	4/21/99	108	20.4	1.4	0.07	0.22	1.6
	Buck Mountain Overflow	Green Power Inc.	54920102	5/24/99	108	19.8	1.7	0.09	0.26	1.7
	Buck Mountain Overflow	Green Power Inc.	54920102	6/27/99	70.2	21.7	1.4	0.07	0.29	1.5
	Buck Mountain Overflow	Green Power Inc.	54920102	7/18/99	108	20.4	1.6	0.17	0.29	1.4
	Buck Mountain Overflow	Green Power Inc.	54920102	8/30/99	127.9	19.8	1.9	0.14	0.24	1.3
	Buck Mountain Overflow	Green Power Inc.	54920102	9/25/99	70.2	18.6	2.1	0.18	0.25	1.8
	Buck Mountain Overflow	Green Power Inc.	54920102	10/19/99	108	19.4	1.5	0.16	0.26	1.3
	Buck Mountain Overflow	Green Power Inc.	54920102	11/24/99	150	29.3	1.6	0.15	0.28	1.7
	Buck Mountain Overflow	Green Power Inc.	54920102	12/22/99	108	20.8	1.8	0.19	0.3	1.9
				Average =	116.24	21.24	1.72	0.17	0.27	1.66
				StDev =	53.49	5.26	1.74	0.22	0.04	0.55

Note: All concentrations are in units of milligrams per liter (mg/l); all discharge measurements are in units of gallons per minute (GPM)
"*" signifies no data were collected

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.