RAUSCH CREEK WATERSHED

TMDL

For Acid Mine Drainage Affected Segments

Prepared by the Pennsylvania Department of Environmental Protection

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Introduction

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Rausch Creek Watershed. 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 (shown in Table 1). High levels of metals, and in some areas depressed pH, caused these impairments. The East Branch of Rausch Creek is also impaired by excessive sediment contributions. All impairments resulted from acid mine drainage from abandoned coal mines and sedimentation from abandoned mine lands. The TMDL addresses the three primary metals associated with acid mine drainage (iron, manganese, aluminum), and pH. A narrative qualitative discussion addresses the sedimentation problem in the East Branch of Rausch Creek.

Table 1. 303(d) Sub-List

State Water Plan (SWP) Subbasin:					06-C-Mahantango Basin			
Year	Miles	Segment ID	DEP Stream Code	Stream Name	Designated Use	Data Source	Source	Cause
1996	1.7		17266	Rausch Creek	CWF	305(b) Report	Resource Extraction	Metals
1998	1.66	2202	17266	Rausch Creek	CWF	SWMP	AMD	Metals
1998	0.03	970925-1030-MAF	17266	Rausch Creek	CWF	SWMP	AMD	Siltation Metals pH
2000	No additional assessment data was collected after publication of the 1998 303(d) list. The 1998 listing of segment ID 970925-1030-MAF is in error for this stream segment and this listing should only apply to the East Branch of Rausch Creek.							
1996	3.5		17267	West Branch Rausch Creek	CWF	305(b) Report	Resource Extraction	Metals
1998	3.53	2203	17267	West Branch Rausch Creek	CWF	SWMP	AMD	Metals
1998	0.06	970925-1030-MAF	17267	West Branch Rausch Creek	CWF	SWMP	AMD	Siltation Metals,pH
2000	No additional assessment data was collected after publication of the 1998 303(d) list. The 1998 listing of segment ID 970925-1030-MAF is in error for this stream segment and this listing should only apply to the East Branch of Rausch Creek.							
1996	1.9		17268	East Branch Rausch Creek	CWF	305(b) Report	Resource Extraction	Metals
1998	1.87	2204,	17268	East Branch Rausch Creek	CWF	SWMP	AMD	Metals
1998	0.65	970925-1030-MAF	17268	East Branch Rausch Creek	CWF	Unassessed Project	AMD	Siltation Metals pH
2000	The two 1998 listings should be combined to show impairment due to AMD and causes of metals, pH, and siltation. No additional assessment data was collected after publication of the 1998 303(d) list.							

CWF - Cold Water Fishery
SWMP - Surface Water Monitoring Program

Directions to the Rausch Creek Watershed

The Rausch Creek Watershed is located in Southwest Schuylkill County, approximately 30 miles Northeast of Harrisburg. To visit the site take Route 81 to Exit 33, Route 209. Proceed south on Route 209 towards Tower City for approximately one mile to the crossroads in the village of Joliett. Turn right onto SR4011 and proceed two miles to stop sign in village of Good Spring. Turn left onto SR4011 and proceed approximately two miles to headwaters of the East Branch Rausch Creek.

Segments addressed in this TMDL

There are eight (8) active mining operations in the watershed. Five (5) of the operations do not have NPDES Permits or discharges. One (1) operation has an NPDES Permit but has never had a discharge. Two (2) of the operations are deep mines that pump and have routine discharges. All other discharges in the watershed are from abandoned mines 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 will be addressed as a separate TMDL. These TMDLs will be expressed as long-term, average loading. 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 following eight (8) active mining operations are in the watershed.

Table 2. Active Mine Permits in this TMDL

Permittee Name	Operation	Coal Surface Mining Permit No.	NPDE Permit No.	Type Permit	Outflow Number	Receiving Stream
K & C Coal Company		54851319	PA 0223174	Deep Mine	1EBRC	East Branch
The Harriman Coal Corporation	Good Spring South	54930102RC7	PA0223492	Surface Mine of Premined Area	No Discharge	East Branch
The Harriman Coal Corporation	Good Spring West	54803019	N/A	Surface Mine	No Discharge	N/A
The Harriman Coal Corporation	Kocher Breaker	54850207	N/A	Preparation Plant	No Discharge Closed System	N/A
E & E Fuels/Rustler Coal		54901302R	PA0594792	Deep Mine	1WBRC	West Branch

Permittee Name	Operation	Coal Surface Mining Permit No.	NPDE Permit No.	Type Permit	Outflow Number	Receiving Stream
The Harriman Coal Corporation	Markson	54803203	N/A	Silt Recovery	No Discharge	N/A
The Harriman Coal Corporation	Shoener and Raub	54820203	N/A	Silt Recovery	No Discharge	N/A
Porter Associates	Porter Mine	54890105	N/A	Backfilling with Fly Ash	Pit No Discharge	N/A

The designations for these stream segments can be found in PA Title 25 Chapter 93.

Watershed History

The Rausch Creek Watershed totals 9.77 square miles in area (Attachment A). The West Branch of Rausch Creek, flowing to the east, drains 4.77 square miles between Bear Mountain and Big Lick Mountain, while the East Branch of Rausch Creek, flowing to the west drains 4.21square miles between Good Springs Mountain and Big Lick Mountain. Rausch Creek drains 0.79 square miles and is formed at the confluence of the two branches and flows northerly through Bear Gap to Pine Creek. The principle source of water in the three branches of Rausch Creek is abandoned mine discharges. The rugged contours of the landscape promote little use except for mining, hunting and lumbering.

The watershed was extensively deep mined in the early 1900s and contains five large abandoned mine pools; the Williamstown-Lykens, Brookside, Markson, Good Spring No. 1 and Good Spring No. 3. The pools where formed when the deep mine collieries were abandoned and pumping ceased. Preregulation surface strip mining of the coal seam outcrops increased the flow of water into the mine pools. The mines are separated from one another by barrier pillars (areas of unmined coal), which keep the mine pools largely segregated from one another.

The Williamstown-Lykens pool is located beneath the western end of the West Branch of Rausch Creek watershed but does not discharge into the watershed. It discharges to the southwest from the Big Lick Tunnel and flows into Wiconisco Creek.

The Brookside Mine pool discharges into the West Branch of Rausch Creek at the Valley View Tunnel (2WBRC) at elevation 915 feet above sea level. Flows from the Brookside Pool range from 0.70 mgd to 5.20 mgd, averaging 2.84 mgd. The water quality and flow data for the Valley View Tunnel discharge is shown in Attachment E.

The Markson Mine Pool discharges into Rausch Creek from the Markson Airway (1RC) at an elevation of 865 feet above sea level. Flows from the Markson Pool range from 1.21 mgd to 10.67 mgd; averaging 3.40 mgd. The water quality and flow data for the Markson Airway discharge is shown in Attachment E.

The Good Spring No. 1 Pool discharges into the East Branch of Rausch Creek from the Orchard Airway (3EBRC) at an elevation of 1,104 feet above sea level. Flows from the Orchard Airway range from 0.18

mgd to 1.27 mgd, averaging 0.32 mgd. The water quality and flow data for the Orchard Airway discharge is shown in Attachment E.

The Good Spring No. 3 mine pool is located beneath the eastern end of the headwaters of the East Branch of Rausch Creek but does not discharge into the watershed. It discharges to the east from the Tracy Airway at an elevation of 1,155 feet above sea level into Good Spring Creek, a tributary of Swatara Creek.

In March 1969, the Pennsylvania Department of Mines and Mineral Resources commissioned Anthracite Research and Development Company, Inc., to determine the best means to abate acid mine drainage contaminating Rausch Creek and receiving streams. The three possible approaches evaluated were: (1) Individual treatment at the source: (2) Strategically located treatment units and: (3) A single treatment plant north of Bear Gap prior to confluence of Rausch Creek with Pine Creek.

Individual treatment of the sources of the acid water was economically feasible, but operation, maintenance and control would be physically difficult and would equate or be greater than single plant operation. Shock loading of the stream could also occur through temporary individual plant operation failure. Three major sources of abandoned or unknown ownership discharges, that at the time totaled 62% of the total flow, would also have to be addressed. Therefore, it was recommended the best approach to treat the acid mine drainage polluting Rausch Creek was to treat the total flow at or immediately north of Bear Gap prior to mixing with Pine Creek.

Construction of the Rausch Creek Treatment Plant was completed in 1973. It is located on Rausch Creek approximately 0.8 miles upstream of the confluence with Pine Creek. The entire flow of Rausch Creek is intercepted at the headworks and diverted into the treatment plant. The plant is capable of treating a maximum of 16 million gallons per day, however after periods of heavy rainfall flows have exceeded 150 million gallons per day. When the flow is in excess of 16 mgd, the excess flow is neutralized with a lime slurry and by-passed in the stream channel around the plant.

The acidic waters taken into the plant flow into a 17 x 17 foot flash mixer where a lime slurry is added. The neutralized water then flows into two aeration tanks where it is aerated to oxidize the iron. At the effluent of the aeration tanks a polymer is added to assist in flocculation. The aerated water then passes into two 90 foot diameter clarifiers where the precipitated iron is settled out. The clear water flows through two large polishing lagoons and back into the original streambed. The iron sludge from the clarifiers is further processed in a thickener where the solids are increased to approximately 5.0 %. The sludge is then processed on a belt filter press where the solids are further increased to approximately 20 % and trucked to the disposal area. The supernatant from the thickener and a portion of the sludge from the clarifier is circulated to the flash mixer to assist in neutralizing the plant influent.

A project to replace out dated equipment and controls at the Rausch Creek AMD Treatment Plant is in the initial stages. The improvements will increase the hydraulic capacity of the plant to 20 mgd and increase the efficiency.

In recent years remining operations in the watershed have been responsible for backfilling numerous abandoned strip pits and reducing the recharge to the mine pools. The Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation also backfilled a 44 acre sit on the south side of Big Lick Mountain, south of the East Branch through the Abandoned Mine Lands Program.

TMDL Endpoints

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 daily concentrations. These long-term average daily 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. PA does have a dissolved criterion for iron. However, 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 3. 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	N/A

*-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 criteria were substituted for the PA criteria for this evaluation.

**-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

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).

Analysis of available data indicates there is no single “critical flow condition for pollutants. Furthermore, there is no significant correlation between source flows and pollutant concentrations. The following table shows the correlation, R-square computed, between flow and the various parameters at point 2RC. The regression analysis was performed with sample data from 1998 through1999. The flow value used for this point for the purpose of the TMDL computation is slightly higher and comes from 20 years of historical flow data at the treatment plant.

Table 4. Rausch Creek Regression Analysis					
Sample Point ID	**Flow vs**				**Number of Samples**
	Aluminum	**Iron**	**Manganese**	**Acidity**	
2RC	0.01	0.28	0.63	0.06	48

These analyses were performed by using the regression function found in Microsoft Excel.

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).

For situations where all of the impact is due to non-point sources, the equations shown below are applied using data for a point in the stream. The load allocation (LA) 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 non-point sources, the same type of evaluation is used. Allocations will include both the point and non-point sources.

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[1]. 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 99[th] 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)

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

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.

Hydrology

The flow information used in the TMDL computations was derived from a combination of measured points and application of unit area flow rates. The sites that have measured flow values in the watershed include 3 deep mine openings, and the inlet to the Rausch Creek Treatment Plant. Based on this information, flows were determined for the mouth of both the East and West Branches of Rausch Creek. Table 5 shows the flow rates for the measured and computed points. A more detailed explanation of the flow derivation is found in Attachment E.

Table 5. Flow Determinations

Point Identification	Flow (mgd)	Determination Method
Inlet – Rausch Creek Treatment Plant (2RC)	8.7	Average of 19 years of daily flow measurement, each year was averaged and then the average value of the 19 yearly values was averaged, There is a parshall flume installed at the treatment plant inlet
Markson Airway (1RC)	2.9	Average flow value, taken at sample collection intervals, based on weir installed at outflow.
Orchard Airway (3EBRC)	0.3	Average flow value, taken at sample collection intervals, based on weir installed at outflow.
Valley View Tunnel (2WBRC)	2.8	Average flow value, taken at sample collection intervals, based on weir installed at outflow.
5EBRC (mouth east branch)	1.5	Computed base on the drainage area of the east branch as compared to the entire watershed. Calculation are shown in attachment E
3WBRC(mouth of west Branch	4.1	Computed base on the drainage area of the west branch as compared to the entire watershed. Calculation are shown in attachment E

TMDLs By Segment

East Branch Rausch Creek

The East Branch Rausch Creek Watershed (Attachment B) has a drainage area of approximately 4.21 square miles and includes 2.52 miles of stream. It originates in the large abandoned strip mine area in the southeast area of the watershed. The Orchard Airway (3EBRC) which discharges water from the Good Spring No.1 Mine Pool is the largest single source of acid mine drainage in the watershed.

There are also seven (7) permitted mining operations in the watershed as listed on Table 2. The K & C Coal Company is the only operation with an NPDES Permit and an active discharge. The Harriman Coal Corporation, Good Spring South surface mine operation has an NPDES Permit but does not have an active discharge. The Harriman Coal Corporation; Good Spring West, Kocker Breaker, Markson and

Shoener & Raub operations do not have NPDS Permits or active discharges. The Porter Associates Porter Mine is a fly ash surface mine backfilling operation that also does not have an active discharge.

TMDL Calculations

The TMDL for East Branch Rausch Creek consists of a wasteload allocation for the K&C Coal Company discharge and a load allocation for the rest of the area above sampling point 5EBRC (Attachment B). This is just upstream of the confluence with West Branch Rausch Creek and includes all the mining impacts for the entire stream segment.

There is currently an entry for this segment on the Pa 303(d) list for impairment due to metals, pH, and sediment. The TMDL computation for sedimentation was not completed in the same manner as the other parameters and is shown separately. Allocations are made for aluminum, iron and manganese at point 5EBRC. The parameter of pH is addressed through a reduction to acidity.

The wasteload allocation (WLA) for the K&C discharge is a daily loading value based on their current permit requirements. This is not a continuous point source discharge. The discharge results from pumping water from the deep mine to their treatment pond when necessary. After treatment the water is then discharged to the stream. This WLA reserves a portion of the allowable load determined for point 5EBRC for allocation to this discharge.

The entire watershed has been affected by mining and upstream sampling data at point 3EBRC with acceptable pH values but, no buffering capacity. Data collected at point 5EBRC that show pH ranging from 4.5 to 6.8 are used to evaluate acid loading in the stream. The objective is to reduce acid loading to the stream which will in turn raise the pH to the desired range. Sampling point 5EBRC has the lowest pH so the alkalinity at 5EBRC 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 allocations for this stream segment were computed using water quality sample data collected at point 5EBRC. In-stream flow measurements were not available for point 5EBRC. The estimated average flow of 1.5 mgd was used for these calculations. Refer to the Hydrology section, or Attachment E for more detailed information on the flow determination for this point.

An allowable long-term average in-stream concentration was determined at point 5EBRC for aluminum, iron, and manganese. The analysis is designed to produce an average daily 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 daily average concentration that needs to be met to achieve water-quality standards. Table 6 shows the allowable loading values for this stream segment. The load was calculated using the average flow value determined by the method described above.

Table 6 East Branch Rausch Creek (5EBRC) Allowable Loads						
		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
	Al	3.1	39.4	0.16	2.0	95%
	Fe	4.4	55.0	0.26	3.3	94%
	Mn	2.6	32.7	0.57	7.2	78%
	Acidity	10.7	133.4	1.70	21.3	84%
	Alkalinity	8.8	110.2			

The allowable loading values shown in Table 6 represent the TMDL for point 5EBRC.

The wasteload allocation for this segment was determined by translating the existing permit requirements to daily loading values. This is an intermittent discharge, and for this reason an estimated flow and duration of discharge was used to determine the daily loading from this discharge. The treatment pond discharge flow is estimated at 18 –20 gallons per minute (gpm) and occurs 8 hours per day, 4 days per week. The wasteload allocation assumes that the discharge occurs daily for 8 hours at the flow of 20 gallons per minute. The wasteload allocation was done for iron and manganese, aluminum is not included in the permit. Acidity was not part of the wasteload allocation because the permit specifies that pH be maintained between 6 and 9. If it is determined that is an increase in discharge flow we may re-evaluate this wasteload allocation.

The daily average permit limits for iron and manganese are 6 and 4 mg/l respectively.

The daily loading for these parameters is computed as follows:

Flow (mgd)*Concentration*8.34*0.33(hours/day) = lbs/day

(20 gpm * 1440 min/day)/1,000,000 = 0.0288 mgd

Iron
0.0288 mgd * 6 mg/l * 8.34 * 0.33 = 0.48 lbs/day

Manganese
0.0288 mgd * 4 mg/l * 8.34 * 0.33 = 0.32 lbs/day

Table 7. East Branch Rausch Creek Allocations					
Parameter	TMDL (lbs/day)	WLA	% Reduction WLA	LA	% Reduction LA
Aluminum	2.0			2.0	95%
Iron	3.3	0.5	0	2.8	95%
Manganese	7.2	0.3	0	6.9	79%
Acidity	21.3			21.3	84%

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:

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

An additional margin of safety is built in to these calculations because point source discharge does not occur on a daily basis.

Seasonal Variation

Seasonal variation is implicitly accounted for in these TMDLs because the data used represents a two-year period, and accounts for 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 estimated average flow for this point was used to derive loading values for the TMDL.

Impairment due to sedimentation

The sediment impairment noted in the East Branch is due to runoff from un-reclaimed abandoned mine lands, and large refuse piles from historic mining. There is one permitted coal processing operation in the watershed, which is in compliance with their permit. The overwhelming majority of the sediment contribution comes from abandoned mine land. An existing sediment load was computed using the GWLF model. This model is being used by the Department to address sedimentation problems in other watersheds throughout the Commonwealth. A reference watershed approach is used to determine the sediment load reduction needed in for this watershed. The West Branch of Rausch Creek was selected for use as the reference watershed. The West Branch of Rausch Creek is impaired by AMD, however does not have a sediment problem, and is an appropriate reference for this purpose. The sediment reduction goal for the TMDL is based on setting the watershed loading rate of the impaired East Branch of Rausch Creek equal to the watershed loading rate in the un-impaired West Branch of Rausch Creek. The load reduction for sediment in the East Branch of Rausch Creek was assigned to disturbed land. The disturbed land use is a combination of areas identified as coal mines and quarries in the land cover data set used for this analysis.

The TMDL for sediment results in a 64% reduction in loading from disturbed land. A more detailed explanation of sediment calculations is contained in Appendix F.

West Branch Rausch Creek

The West Branch Rausch Creek Watershed is located west of the East Branch Rausch Creek Watershed (Attachment B). It originates in a swamp on Pennsylvania State Game Lands and flows 3.53 miles to the confluent with the East Branch. Abandoned small deep and strip mines line the mountainside slopes north and south of the West Branch of Rausch Creek. Only a small percentage of them have been reclaimed. The Valley View Tunnel (2WBRC) which discharges water from the Brookside Mine Pool is the largest single source of water / acid mine drainage in the watershed.

E and E Fuels has a permitted discharged (1WBRC) to the West Branch Rausch Creek under Permit No. 54901302. This discharge is associated with deep mining permit. This is not a continuous discharge. The discharge results from pumping water from the deep mine to their treatment pond when necessary. After treatment the water is then discharged to the stream.

TMDL Calculations

The TMDL for West Branch Rausch Creek consists of a wasteload allocation to the E&E fuels discharge and a load allocation to all of the area above sampling point 3WBRC as shown on Attachment A. This is just upstream of the confluence with East Branch Rausch Creek and includes all the mining impacts for the entire stream segment.

The load allocation for this stream segment was computed using water quality sample data collected at the point 3WBRC. In-stream flow measurements were not available for point 3WBRC. Flow for this point was estimated using the unit-area hydrology from a known point (2RC) on Rausch Creek. The estimated average flow of 4.1 mgd was used for these calculations.

The wasteload allocation (WLA) for the E&E discharge is a daily loading value based on their current permit requirements. This WLA reserves a portion of the allowable load determined for point 3WBRC for allocation to this discharge.

An allowable long-term average in-stream concentration was determined at point 3WBRC for aluminum, iron, and manganese. The analysis is designed to produce an average daily 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 daily average concentration that needs to be met to achieve water-quality standards. Table 8 shows the allowable loading values for this stream segment. The load was calculated using the average flow value as determined by the method described above.

Table 8. West Branch Rausch Creek (3WBRC) Allowable Loads						
		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
	A1	0.2	8.0	0.17	5.7	28%
	Fe	15.1	517.7	0.91	31.1	94%
	Mn	1.6	55.4	0.73	24.9	55%

The allowable loading values shown in Table 5 represent the TMDL for point 3WBRC.

The wasteload allocation for this segment was determined by translating the existing permit requirements to daily loading values. This is an intermittent discharge, and for this reason an estimated flow and duration of discharge was used to determine the daily loading from this discharge. The treatment pond discharge flow is estimated at 8 –10 gallons per minute (gpm) and occurs 8 hours per day, 2 days per week. The wasteload allocation assumes that the discharge occurs daily for 8 hours at the flow of 10 gallons per minute. The wasteload allocation was done for iron and manganese, aluminum is not included in the permit. If it is determined that is an increase in discharge flow we may re-evaluate this wasteload allocation.

The daily average permit limits for iron and manganese are 6 and 4 mg/l respectively.

The daily loading for these parameters is computed as follows:

Flow (mgd)*Concentration*8.34*0.33(hours/day) = lbs/day

(10 gpm * 1440 min/day)/1,000,000 = 0.0144 mgd

Iron
0.0144 mgd * 6 mg/l * 8.34 * 0.33 = 0.24 lbs/day

Manganese
0.0144 mgd * 4 mg/l * 8.34 * 0.33 = 0.16 lbs/day

Table 9. West Branch Rausch Creek Allocations					
Parameter	TMDL (lbs/day)	WLA	% Reduction WLA	LA	% Reduction LA
Aluminum	5.7			5.7	28%
Iron	31.1	0.2	0	29.9	94%
Manganese	24.9	0.2	0	24.7	55%

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:

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

  An additional margin of safety is built in to these calculations because point source discharge does not occur on a daily basis.

Seasonal Variation

Seasonal variation is implicitly accounted for in these TMDL's because the data used represent a two-year period, and accounts for 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 estimated median flow for this point was used to derive loading values for the TMDL.

Rausch Creek

Rausch Creek is formed at the confluence of the East and West Branches of Rausch Creek and flows north through Bear Gap a distance of 1.66 miles to Pine Creek. In Bear Gap steep slopes line both banks of the creek. Several abandoned deep mine openings are located there. The Markson Airway (1RC) which discharges water from the Markson Mine pool is the largest source of water / acid mine drainage in the Rausch Creek watershed.

The Rausch Creek AMD Treatment plant is located approximately 0.86 miles downstream on Rausch Creek. Water quality and flow data for the influent (2RC) and effluent (3RC) at the Rausch Creek AMD Treatment plant are shown in Attachment E.

TMDL Calculations

The TMDL for Rausch Creek consists of a load allocation to all of the area above sampling point 2RC as shown on Attachment B.

The load allocation for this stream segment was computed using water quality sample data collected at point 2RC (treatment plant intake). The average flow at this point of 8.7 mgd was used for these calculations. More detailed information on the flow determination is shown in attachment E.

An allowable long-term average in-stream concentration was determined at point 2RC for aluminum, iron, manganese, and acidity (surrogate for pH). The analysis is designed to produce an average daily 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 log normally 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 daily average concentration that needs to be met to achieve water-quality standards. Table 10 shows the allowable loading values for this stream segment. The load was calculated using the average flow value determined by the method described above.

Table 10. Rausch Creek (2RC) Allowable Loads

		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA conc (mg/l)	Load (lbs/day)	%
	A1	1.3	16.6	0.23	2.8	83%
	Fe	12.3	153.6	0.98	12.3	92%
	Mn	3.0	37.3	0.66	8.2	78%
	Acidity	21.7	271.0	1.95	24.4	91%
	Alkalinity	8.8	110.2			

The allowable loading values shown in Table 10 represent load allocations made at point 2RC.

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:

- 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 TMDL's because the data used represent a two-year period, and accounts for 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 estimated average flow for this point was used to derive loading values for the TMDL.

Summary of Allocations

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

Table 11. Rausch Creek Watershed Allowable Loads

		Measured Sample Data		Allowable		Reduction Identified
Station	Parameter	Conc (mg/l)	Load (lbs/day)	LTA Conc (mg/l)	Load (lbs/day)	%
5EBRC	In stream monitoring point located on East Branch Rausch Creek					
	Al	3.1	39.4	0.16	2.0	95%
	Fe	4.4	55.0	0.26	3.3	94%
	Mn	2.6	32.7	0.57	7.2	78%
	Acidity	10.7	133.4	1.70	21.3	84%
3WBRC	In stream monitoring point located on West Branch Rausch Creek					
	Al	0.2	8.0	0.17	5.7	28%
	Fe	15.1	517.7	0.91	31.1	94%
	Mn	1.6	55.4	0.73	24.9	55%
2RC	Monitoring point located on Rausch Creek (Treatment Plant Intake)					
	Al	1.3	16.6	0.23	2.8	83%
	Fe	12.3	153.6	0.98	12.3	92%
	Mn	3.0	37.3	0.66	8.2	78%
	Acidity	21.7	271.0	1.95	24.4	91%

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

Recommendations

One goal of any project in the watershed would be to reduce the amount of surface recharge into the mine pools. Backfilling abandoned strip pits, deep mines and crop falls to approximate original contours with drainage ditches and vegetation will divert surface runoff back into the stream channels. This will also help to dilute the affects of the acid mine drainage reaching the stream.

Mining of previously mined areas by the coal mining industry would also benefit remediation. Considering the extensive coal reserves in the watershed a large strip mining operation could day light and backfill portions or all of a mine pool, reducing or eliminating the mine pool discharge. Projects to take advantage of the Rausch Creek AMD Treatment plant by reducing the effects of acid mine drainage in adjacent watersheds should also be undertaken.

For both the East and West branches of Rausch Creek the opportunities to reduce or eliminate the flow coming from mine pools will be explored. A combination of the above mentioned activities may result in decreased flows from the mine pools and provide a large reduction in the mine drainage affects in these streams.

Some of the practices have already been implemented. For example, Department of Environmental Protection, Bureau of Abandoned Mine Reclamation, through the Abandoned Mine Lands Program completed Project No. OSM 54(3010) 101.1, backfilling strip pits and mine openings in the East Branch of Rausch Creek. Forty-four acres containing pre-act deep mine openings, and strip pits were filled in, graded and vegetated. The area is now grassland.

The Rausch Creek Watershed is unique because of the abandoned mine pool outflows that contribute such a large percentage of the total watershed flow and the Rausch Creek AMD Treatment Plant constructed to treat that flow. The treatment plant was constructed because it was the best option for treatment of the mine drainage problem in the watershed. The treatment plant has been successful in decreasing the pollution load coming from the watershed. Using the average values for the treatment plant effluent (point 3RC) and flow taken at the plant inlet (point 2RC) the loads leaving the plant can be computed and compared to the TMDL values computed at point 2RC. The influent, effluent, and allowable loads are shown in Table 8.

Table 12. Treatment Plant Efficiency (Point 3RC)

Parameter	Influent Load	Effluent Load	Allowable Load	Current % Reduction	% Reduction specified in the TMDL
Aluminum	96.6	20.5	16.4	79%	83%
Iron	890.8	45.4	71.3	95%	92%
Manganese	216.4	75.6	47.6	65%	78%
Acidity	1571.9	2.0	141.5	100%	91%

The treatment plant is currently meeting the TMDL objectives for Iron and Acidity. The removal of aluminum is very near the TMDL objective and the manganese removal is substantial but needs to be improved to meet the objective.

Funds to upgrade the Rausch Creek AMD Treatment Plant have been approved. The upgrades are intended to increase the hydraulic capacity and efficiency of the plant. This will assist in meeting the remediation standards and enable additional mine water from adjacent watersheds to be diverted and treated.

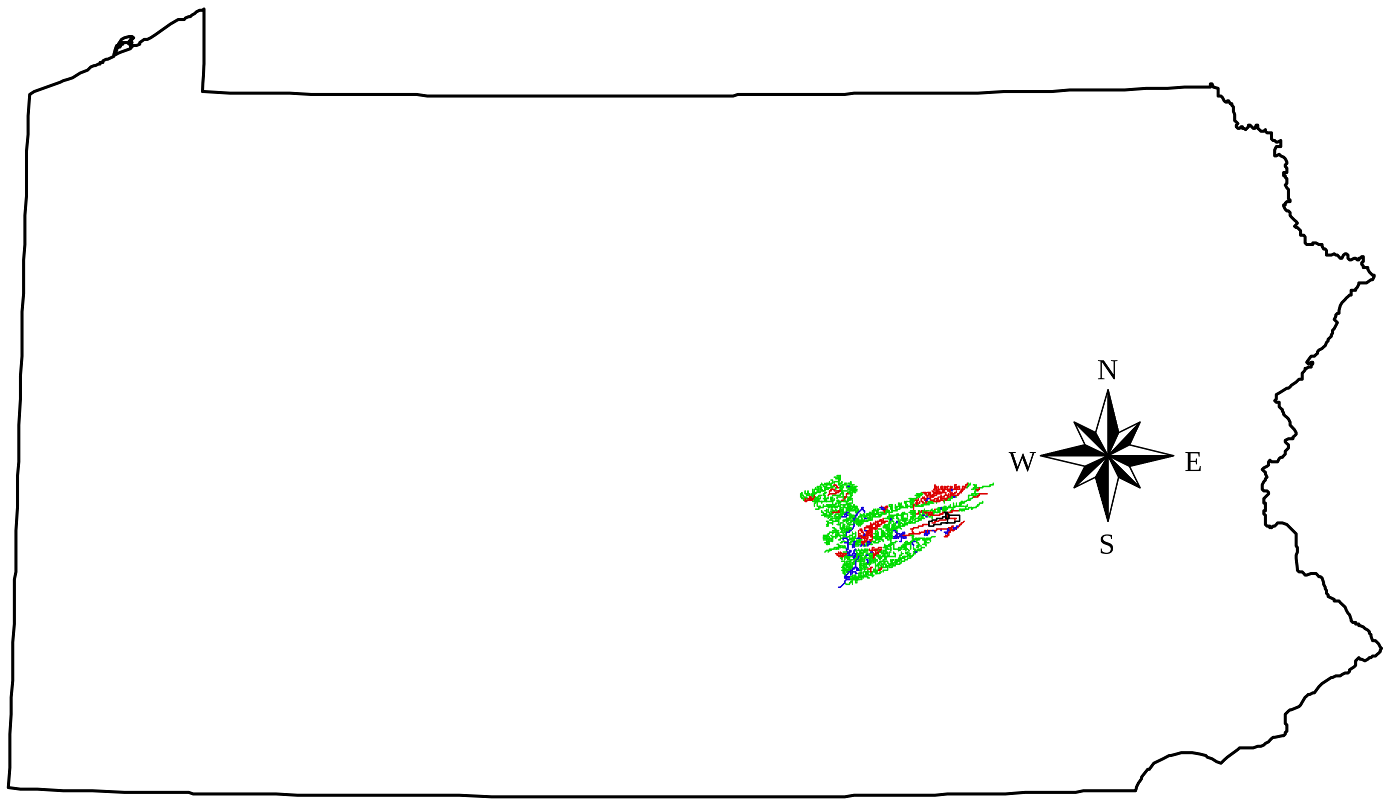
Public Participation

Notice of the draft TMDLs was published in the *PA Bulletin* on December 16, 2000 with a 60 day comment period that ended on February 13, 2001. Notice of the draft TMDL and public meeting was also published in a local newspaper. A public meeting with watershed residents was held Tuesday, January 9, 2001 at the Hegins Township Water Authority in Valley View, PA to discuss the TMDLs. Notice of final TMDL approval will be posted on the Department website.

Attachment A

Location of Rausch Creek

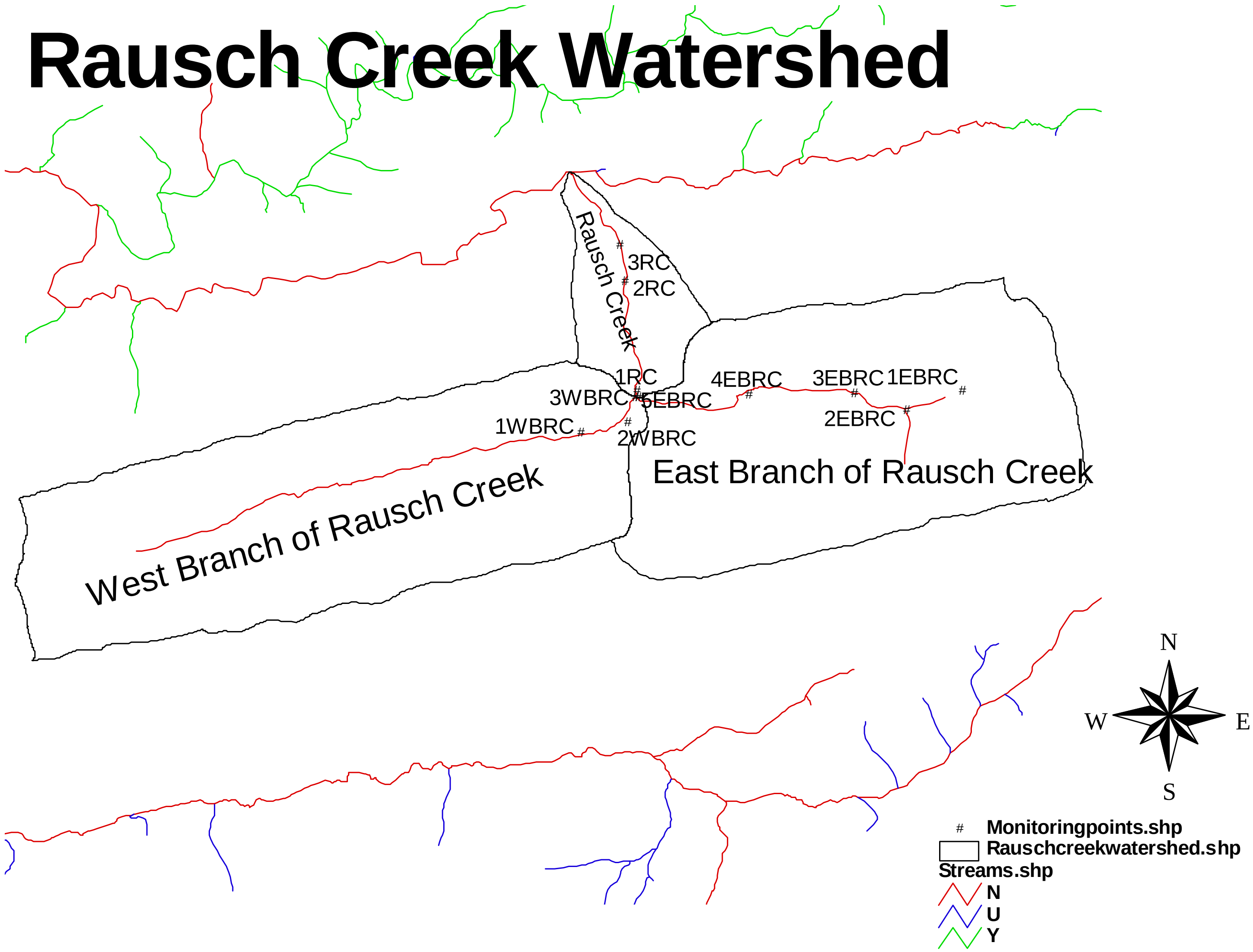
Location of Rausch Creek Watershed



Attachment B

Rausch Creek Watershed

Rausch Creek Watershed



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[1] 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.[2] 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.

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

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[1] 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.

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

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.

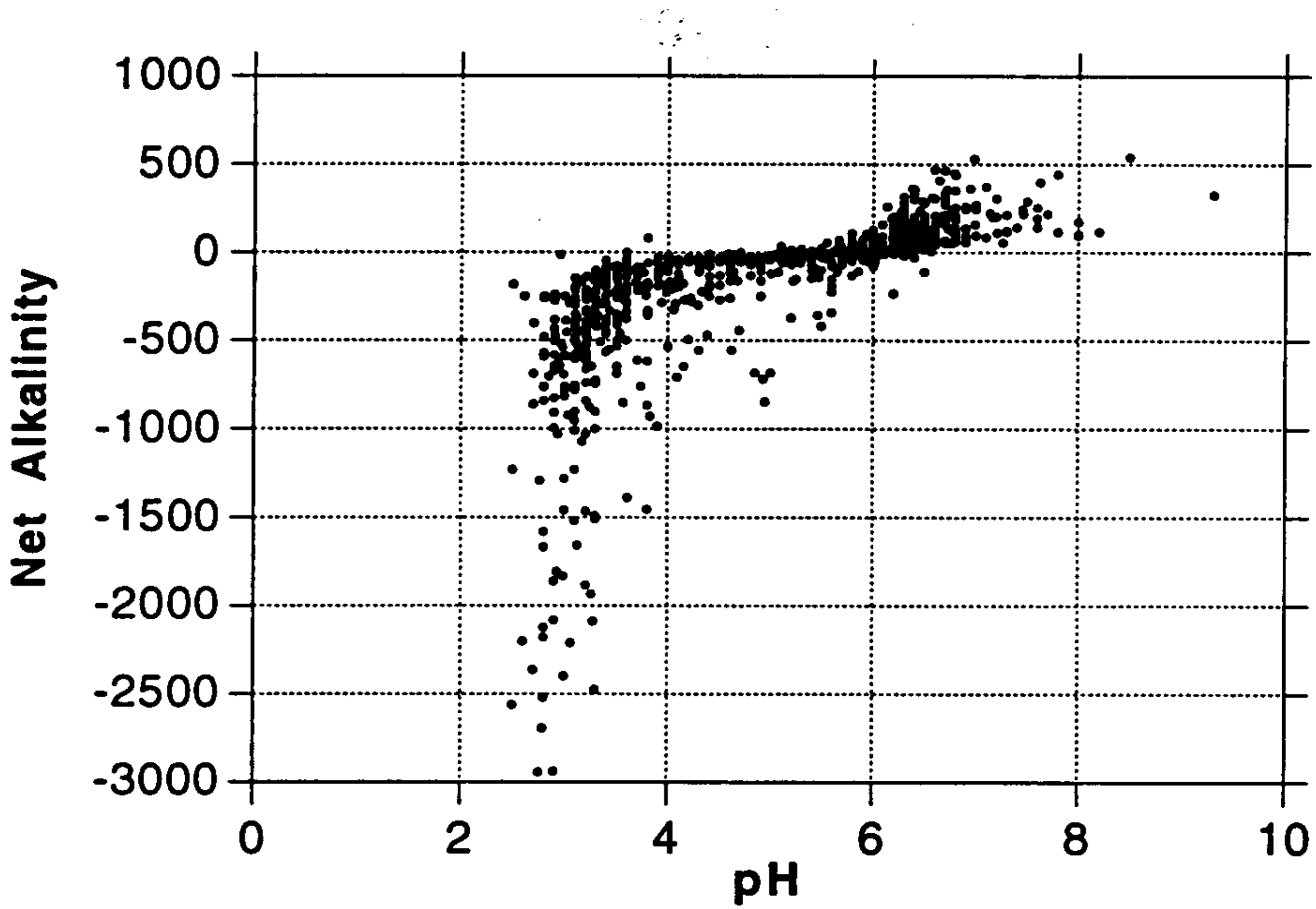


Figure 1.2, Graph C, net alkalinity vs. pH, page 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in PA

Attachment D

Example Calculation: Lorberry Creek

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 99th 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 99th 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 TMDLs

	Rausch Creek Treatment Plant Influent (2RC)							
TEST		00403	00410	70508	01045A	01047A	01055A	01105A
				Hot	Total	FERROUS	Total	Total
DATE	FLOW	PH	Alk.	Acidity	Fe	IRON	Mn	Al
	mgd	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
36157	3.00	4	0	38	16.1	13.02	3.51	0.964
36129	3.25	7.6	24	0	14.5	0.19	3.61	1.81
36094	3.75	3.9	0	34	14.8	10.67	3.76	1.02
36066	3.75	4.2	0	26	12.2	9.13	3.53	0.963
36003	4.13	4.9	2.4	24	11.7	6.93	3.12	1.02
35975	5.75	4.7	1.4	24	8.74	4.83	3.04	1.13
35941	9.38	5.7	3.6	18.2	9.35	7.48	2.56	0.994
35912	14.50	5.5	3.4	15.2	8.44	5.6	2.21	0.941
35884	17.00	5.2	3	19.4	9.56	7.04	2.68	1.03
35849	14.00	5.8	3.6	17.4	9.65	7.04	2.42	1.05
35821	17.00	5.2	3	14.6	8.94	7.37	2.37	1.04
36521	16.00	6.1	7.4	20	13.6	9.9	3.2	1.09
36493	7.00	5.6	3.4	22	11.3	9.02	2.61	1.05
36458	6.00	5	2.4	22	12.1	8.9	3.15	1.2
36430	5.25	4.3	0	34	14.6	9.46	3.36	1.62
36402	5.25	4.8	0	28	15.8	0.14	4.02	1.51
36367	4.25	4.8	2	28	14.1	13.86	3.4	0.776
36339	3.75	5.4	2.8	22	13.8	11.97	3.28	0.946
36304	5.25	6	4.4	15.8	12.1	0.05	2.78	0.919
36276	5.38	7.9	24	-	13.6	0.99	2.91	4.86
36248	8.25	8.8	20	0	12.2	0.37	2.44	0.978
36213	10.13	5	2.6	32	13.1	9.46	3.17	2.57
36185	5.88	4.7	1.2	22	12.1	5.5	1.46	1.13
Avg.	**8.1	5.44	4.98	21.66	12.28	6.91	2.98	1.33
Std. Dev	4.9	1.22	7.25	9.49	2.30	4.18	0.59	0.86

** - This is the average value of this data set. The average flow of 8.7 mgd was used in the TMDL computation. The 8.7 mgd comes from 20 years of historical flow data and is shown on flow calculations sheet at the end of the attachment.

	Rausch Creek Treatment Plant Effluent (3RC)						
		00403	00410	70508	01045A	01055A	01105A
				Hot	Total	Total	TOTAL
DATE	FLOW	PH	Alk.	Acidity	Fe	Mn	Al
	MGD	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
36157		6.2	7.2	0	0.41	1.51	<0.200
36129		6.4	8.4	0	0.44	0.86	<0.200
36094		6.3	8	0	0.27	0.77	<0.200
36066		6.4	9.2	0	0.41	0.52	0.21
36038		6.4	7	0	0.42	1.40	<0.200
36003		6.3	7.6	0.6	0.45	1.28	<0.200
35975		7.7	10.2	0	0.23	0.52	<0.200
35941		6.6	11.6	0	0.61	0.94	<0.200
35912		8	19	0	0.36	0.19	0.21
35884		6.4	9.6	0	0.73	1.97	<0.200
35849		7.1	11.8	0	1.49	1.04	0.28
35821		6.5	11	0	0.75	0.86	0.21
36521		6.2	13	0	1.64	2.09	0.25
36493		6.2	8.8	0	1.10	1.62	<0.200
36458		6.3	7.6	0	0.47	1.45	<0.200
36430		6.3	7.8	0	0.44	0.96	<0.200
36402		6.3	7.6	0	0.47	1.26	<0.200
36367		6.3	7.6	0	0.33	0.88	<0.200
36339		6.6	8.4	0	0.35	0.63	<0.200
36304		6.9	12.2	0	0.42	0.69	<0.200
36276		6.8	12.2	0	0.67	0.80	0.20
36248		6.5	11.2	0	0.56	0.87	<0.200
36185		7.1	8.8	0	1.39	0.87	0.61
Avg.	8.7	6.60	9.82	0.03	0.63	1.04	0.28
Std. Dev.	-	0.48	2.74	0.13	0.40	0.47	0.15

Point 5EBRC							
		00403	00410	70508	01045A	01055A	01105A
				Hot	Total	Total	Total
DATE	FLOW	PH	Alk.	Acidity	Fe	Mn	Al
	MGD	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
36157		6	5.4	5.2	0.53	1.85	1.20
36129		6.1	7	4.2	0.82	2.38	1.41
36094		4.9	2.6	22	19.90	3.47	11.10
36066		6.4	20	0	0.33	2.00	0.30
36038		6.8	30	0	0.55	1.88	0.23
36003		6.7	22	0	2.38	2.31	0.38
35975		6.3	11	1.4	4.34	2.92	1.37
35941		6.1	8.4	5.2	4.36	2.78	1.74
35912		5.4	3.6	11.6	3.40	2.43	2.19
35884		5.9	6.2	11.2	5.35	2.80	2.29
35849		6	6.2	9.4	3.59	2.65	1.67
35821		5.1	2.8	8.8	2.86	2.36	1.40
36521		6.2	11.2	7.4	4.53	2.55	2.25
36493		5.7	4	10.8	4.40	2.38	2.63
36458		4.5	0	40	3.04	4.28	7.34
36430		4.7	1.6	24	3.69	3.13	4.35
36402		4.7	1.6	22	2.51	3.86	4.44
36367		6.6	22	0	1.87	1.84	1.22
36339		5.7	3.2	6.8	2.60	2.66	3.48
36304		6.6	19.8	0	6.33	1.88	3.95
36276		4.8	2	30	15.70	2.80	10.60
36248		5.4	3.2	14.6	3.80	2.13	3.68
Avg.	1.5	5.75	8.81	10.66	4.40	2.61	3.15
Std. Dev.		0.72	8.45	10.85	4.66	0.64	3.00

	Point 3WBRC						
Test No.		00403	00410	70508	01045A	01055A	01105A
				Hot	Total		
Date	Flow	PH	Alk.	Acidity	Fe	Mn	Al
	MGD	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
12/28/1998		6.3	28.0	0.0	16.00	1.68	<.200
11/30/1998		6.3	24.0	0.0	26.80	1.72	0.27
10/26/1998		6.2	20.0	0.0	16.30	1.89	<.200
9/28/1998		6.3	24.0	0.0	14.30	1.87	<.200
8/31/1999		6.3	22.0	0.0	16.20	1.87	<.200
7/27/1998		6.4	30.0	0.0	16.40	1.70	<.200
6/29/1998		6.4	24.0	0.0	14.40	1.65	0.24
5/26/1998		6.3	30.0	0.0	22.30	1.60	1.02
4/27/1998		6.1	20.0	0.0	15.30	1.26	0.55
3/30/1998		6.3	28.0	2.4	14.00	1.60	<.200
2/23/1998		6.4	28.0	8.2	13.90	1.27	0.28
1/26/1998		6.2	26.0	2.4	11.20	1.30	0.26
12/27/1999		6.5	34.0	0.0	14.70	1.69	0.26
11/29/1999		6.2	20.0	0.0	9.54	1.19	0.27
10/25/1999		6.4	30.0	0.0	13.90	1.61	<.200
9/27/1999		6.2	19.0	0.0	15.00	1.63	0.38
8/30/1999		6.3	24.0	0.0	15.20	1.82	<.200
7/26/1999		6.3	24.0	0.0	14.30	1.93	<.200
6/28/1999		6.4	26.0	0.0	15.00	1.88	<.200
5/24/1999		6.4	28.0	0.0	15.30	1.64	<.200
4/26/1999		6.3	24.0	0.0	12.30	1.54	0.23
3/29/1999		6.3	28.0	0.0	10.80	1.27	0.27
2/22/1999		6.5	26.0	0.0	16.30	1.82	0.33
Avg.	4.1	6.3	25.5	0.6	15.14	1.62	0.37
Std. Dev.		0.1	3.9	1.8	3.60	0.23	0.24

	Markson Airway - Point 1RC						
				Hot	Total		
Date	Flow	PH	Alk.	Acidity	Fe	Mn	Al
	gpm	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
1/27/1997	2438.9	3.7	0.0	64.0	5.64	3.60	2.22
2/26/1997	2332.1	3.6	0.0	64.0	6.75	4.35	1.83
3/31/1997	2332.1	3.6	0.0	60.0	7.37	3.93	2.91
4/29/1997	1920.1	3.5	0.0	80.0	7.95	4.13	1.49
5/29/1997	1820.5	3.5	0.0	82.0	9.78	4.56	1.43
6/25/1997	1820.5	3.5	0.0	84.0	13.80	4.82	1.54
7/24/1997	1627.0	3.6	0.0	96.0	21.80	4.38	1.67
9/29/1997	1041.7	3.6	0.0	102.0	21.10	6.04	1.82
10/27/1997	868.0	3.6	0.0	86.0	24.90	5.92	-
12/16/1997	924.6	3.6	0.0	92.0	26.00	4.97	1.91
1/31/1998	3251.8	3.4	0.0	60.0	8.95	4.36	2.08
2/26/1998	5495.5	3.5	0.0	58.0	8.80	4.04	2.25
3/26/1998	4241.4	3.5	0.0	50.0	5.76	3.95	2.30
5/26/1998	3778.3	3.5	0.0	54.0	5.94	3.74	2.25
6/25/1998	2275.6	3.5	0.0	54.0	5.90	4.52	2.20
7/30/1998	906.6	3.3	0.0	56.0	9.33	4.53	1.95
8/31/1998	938.1	3.5	0.0	64.0	15.70	5.65	2.07
11/30/1998	757.6	3.5	0.0	76.0	24.40	5.78	1.73
12/21/1998	602.3	3.5	0.0	80.0	24.50	5.84	1.64
2/25/1999	1418.3	3.5	0.0	58.0	11.60	4.91	1.84
Avg.	2039.6	3.5	0.0	71.0	13.30	4.70	1.95
Std. Dev.		0.1	0.0	15.7	7.56	0.77	0.36

	Orchard Airway - Point 3EBRC						
				Hot	Total		
Date	Flow	PH	Alk.	Acidity	Fe	Mn	Al
	gpm	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
1/27/1997	246.0	6.3	0.0	0.0	16.6	2.12	0.255
2/26/1997	201.1	6.2	0.0	0.0	9.5	1.90	0.064
3/31/1997	162.0	6.3	0.0	2.8	13.4	2.23	0.044
4/29/1997	222.6	6.3	0.0	19.6	14.3	2.28	0.065
5/29/1997	161.6	6.2	0.0	0.0	0.0	0.00	0.049
6/25/1997	127.5	6.2	0.0	13.6	15.3	2.45	0.054
7/24/1997	554.3	6.0	0.0	11.4	6.8	0.85	0.296
9/29/1997	144.1	6.1	0.0	0.2	14.7	2.22	0.059
10/27/1997	144.1	6.2	0.0	12.6	14.9	2.54	0.080
12/16/1997	144.1	6.2	0.0	10.0	18.9	2.09	0.085
1/31/1998	246.0	6.3	0.0	0.0	10.7	2.06	0.028
2/26/1998	425.0	6.0	0.0	0.0	6.1	1.20	<.200
3/26/1998	295.8	6.5	0.0	0.0	8.8	1.84	0.035
5/26/1998	201.1	6.3	0.0	0.0	11.7	2.01	0.023
6/25/1998	161.9	6.1	0.0	0.0	11.3	2.00	0.400
7/30/1998	161.9	6.0	0.0	0.0	12.9	2.11	0.094
8/31/1998	144.0	6.5	0.0	0.0	14.3	2.51	0.100
11/30/1998	127.0	6.3	0.0	0.0	19.5	2.55	<.200
12/21/1998	112.2	6.2	0.0	0.0	19.9	2.73	<.200
2/25/1999	144.0	6.3	0.0	0.0	16.2	2.62	<.200
5/25/1999	161.9	6.3	0.0	0.0	19.1	2.49	<.200
Avg.	204.2	6.2	0.0	3.3	13.09	2.04	0.108
Std. Dev.		0.1	0.0	6.0	4.98	0.65	0.109

	Valley View Tunnel - 2WBRC						
				Hot	Total		
Date	Flow	PH	Alk.	Acidity	Fe	Mn	Al
	gpm	UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
9/10/1996	-	6.2	38.0	16.8	14.7	1.82	<0.5
9/20/1996	-	5.8	22.0	6.8	13.8	1.73	<0.5
10/3/1996	784.0	6.3	32.0	32.0	13.9	1.70	<0.5
10/24/1996	3590.0	6.3	46.0	5.8	15.1	1.57	<0.5
11/20/1996	2000.0	6.2	50.0	0.0	16.5	1.81	<0.5
2/6/1997	1800.0	6.2	48.0	2.8	14.8	1.76	<0.5
2/26/1997	1912.0	6.3	48.0	0.4	14.1	1.62	<0.5
4/24/1997	1756.0	6.1	48.0	7.0	14.8	1.69	<0.5
12/16/1997	-	6.2	48.0	14.2	17.9	1.93	<0.2
1/31/1998	-	6.3	54.0	19.6	19.5	1.99	0.277
5/26/1998	-	6.2	46.0	4.6	19.0	1.82	0.232
Avg.	1973.7	6.2	43.6	10.0	15.8	1.77	0.255
Std. Dev.		0.1	9.3	9.7	2.1	0.10	0.023

RAUSCH CREEK TMDL			
AVERAGE FLOW CALCULATIONS			
RAUSCH CREEK TREATMENT PLANT AVERAGE DAILY FLOWS, TOTAL IRON AND ACIDITY CONCENTRATIONS			
YEAR	**AVERAGE DAILY FLOW**	**AVERAGE DAILY ACIDITY**	**AVG DAILY IRON CONCENTRATION**
	mgd	**mg/l**	**mg/l**
1981	6.8	78.6	14.8
1982	10.4	46.2	10.3
1983	10.4	78.5	13.1
1984	11.1	65.7	12.3
1985	5.2	72.1	15.5
1986	8.9	69.4	12.1
1987	8.5	60.8	13.7
1988	6.5	60.0	13.8
1989	10.0	67.0	10.2
1990	9.4	65.5	10.9
1991	6.1	64.5	12.4
1992	5.7	55.5	12.6
1993	9.4	51.7	8.9
1994	9.6	54.1	8.6
1995	8.6	53.6	8.8
1996	14.0	49.8	7.9
1997	7.5	52.4	10.4
1998	10.4	43.7	8.9
1999	6.6	47.4	10.3
Averages	8.7	59.8	11.3
Flows taken from parshall flume at inlet of plant			
MARKSON AIRWAY			
2039.6 gpm x 1440 / 1,000,000 = 2.9 mgd			
ORCHARD AIRWAY			
204.2 gpm x 1440 / 1,000,000 = 0.3 mgd			

VALLEY VIEW TUNNEL			
1973.7 gpm x 1440 / 1,000,000 = 2.8 mgd			
Flows taken from weir constructed on outflow			
RAUSCH CREEK TMDL			
FLOW CALCULATIONS			
AVERAGE MEASURED FLOWS			
Rausch Creek		8.7 mgd	
Markson Airway		2.9 mgd	Drains into Rausch Creek
Orchard Airway		0.3 mgd	Drains into East Branch
Valley View Tunnel		2.8 mgd	Drains into West Branch
Total flow from abandoned deep mines		6.0 mgd	
DRAINAGE AREAS OF WATERSHED			
Rausch Creek drainage area		0.79 sq mi	
West Branch Drainage Area		4.77 sq mi	
East Branch drainage area		4.21 sq mi	
Total drainage area of watershed		9.77 sq mi	
CALCULATED FLOW FOR WEST BRANCH RAUSCH CREEK			
{ (8.7 mgd - 6.0 mgd) x 4.77 sq mi / 9.77 sq mi } + 2.8 mgd = 4.1 mgd			
CALCULATED FLOW FOR EAST BRANCH RAUSCH CREEK			
{ (8.7 mgd - 6.0 mgd) x 4.21 sq mi / 9.77 sq mi } + 0.3 mgd = 1.5 mgd			

CALCULATED FLOW FOR RAUSCH CREEK			
{ (8.7 mgd - 6.0 mgd) x .79 sq mi / 9.77 sq mi) + 2.9 mgd + 4.1 mgd + 1.5 mgd = 8.7 mgd			
Calculated flows divide the measured base flow between the three stream segments based on percentage of total drainage area. Measured deep mine outflows are then added to the appropriate stream segment.			

Attachment F

East Branch Rausch Creek Sediment Computations

East Branch Rausch Creek Sediment TMDL Calculation

Table A. Existing Loading Values for East Branch Rausch Creek (impaired)			
Source	**Area (ac)**	**Sediment (lbs)**	**Unit Area Load (lb/ac/yr)**
Hay/Pasture	2.5	113.4	45.9
Cropland	93.9	333,228.2	3,548.8
Coniferous Forest	24.7	493.4	20.0
Mixed Forest	64.2	2,342.3	36.5
Deciduous Forest	1,949.6	486,781.7	249.7
Disturbed	306.4	16,795,923.8	54,817.0
Hi Intensity Urban	17.3	9,571.8	553.4
Total	**2,458.6**	**17,628,454.6**	**7,170.0**

Table B. Existing Loading Values for West Branch Rausch Creek (reference)			
Source	**Area (ac)**	**Sediment (lbs)**	**Unit Area Load (lb/ac/yr)**
Hay/Pasture	4.9	0.0	0.0
Cropland	29.7	343,104.8	11,571.1
Coniferous Forest	17.3	411.7	23.8
Mixed Forest	116.1	6,480.6	55.8
Deciduous Forest	2,658.8	1,694,107.5	637.2
Unpaved Roads	7.4	151,860.1	20,485.7
Disturbed	126.0	7,104,785.3	56,387.2
Total	**2,960.3**	**9,300,750.0**	**3,141.9**

The TMDL target sediment load for East Branch Rausch Creek is the product of the unit area sediment loading rate in the reference watershed (West Branch Rausch Creek) and the total area of the impaired watershed (East Branch Rausch Creek). These numbers and the resulting TMDL target load are shown in Table C.

Table C. TMDL Total Load Computation			
Pollutant	Unit Area Loading Rate in West Branch Rausch Creek (lbs/acre/yr)	Total Watershed Area in East Branch Rausch Creek (acres)	TMDL Total Load (lbs/yr)
Sediment	3141.9	2458.6	7,724,675

TMDL = LA + WLA + MOS

There is no sediment WLA for East Branch Rausch Creek, therefore:

TMDL = LA + MOS

Margin of Safety

The Margin of Safety (MOS) for this analysis is explicit. Ten percent of each of the TMDL was reserved as the MOS.

MOS = 0.1 * 7,724,675

MOS = 772,468 lbs/yr

Load Allocation

The Load allocation (LA), consisting of all nonpoint sources in the watershed, was computed as by subtracting the margin of safety from the TMDL total load.

LA = TMDL – MOS

LA = 7,724,675 lbs – 772,468 lbs

LA = 6,952,207 lbs

Therefore, the difference between the total existing sediment load (from Table X) and the LA and represents the amount that must be reduced in the East Branch Rausch Creek to meet the unit area sediment loading rate in the unimpaired West Branch Rausch Creek.

Load Reduction Required = 17,628,454 – 6,952,207

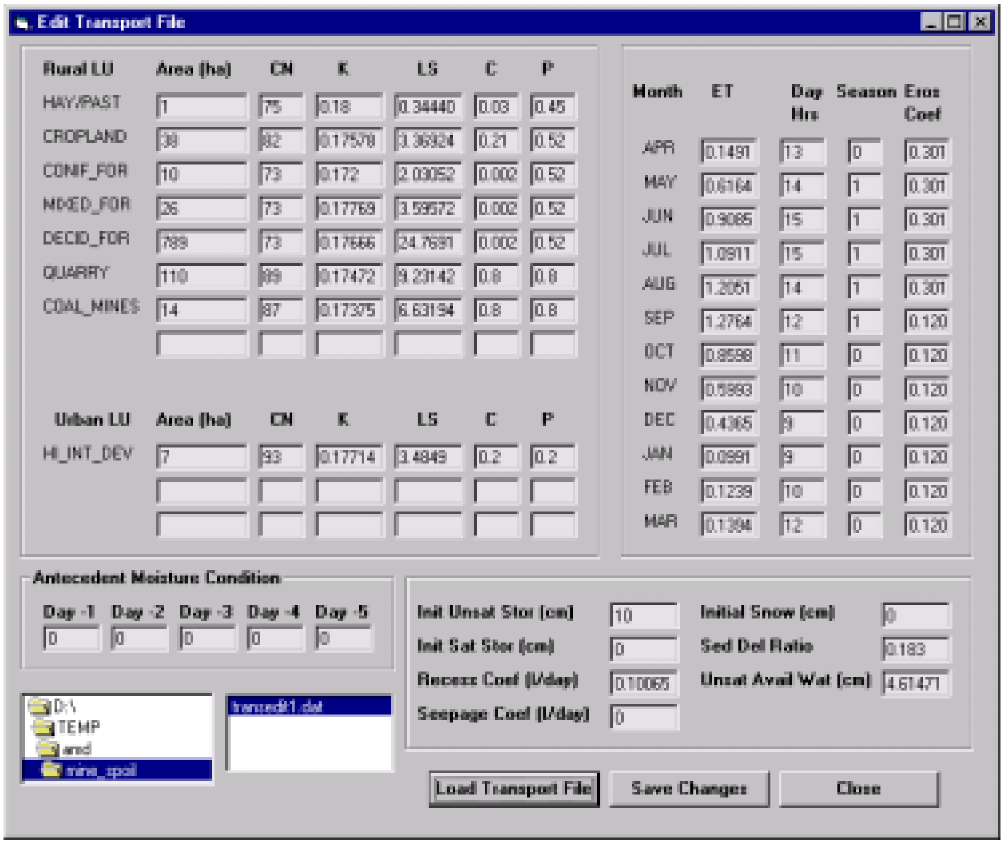
Load Reduction Required = 10,676,247 lbs

This reduction will come entirely from the disturbed land use category resulting in the sediment load allocation presented in Table D.

Table D. TMDL Allocation Table for East Branch Rausch Creek

Source	Area (ac)	Current Sediment Load (lbs)	TMDL Sediment Load (lbs)	% Reduction
Hay/Pasture	2.5	113.4	113.4	0
Cropland	93.9	333228.2	333228.2	0
Coniferous Forest	24.7	493.4	493.4	0
Mixed Forest	64.2	2342.3	2342.3	0
Deciduous Forest	1949.6	486781.7	486781.7	0
Disturbed	306.4	16795923.8	6119676.8	64
Hi Intensity Urban	17.3	9571.8	9571.8	0
Total	**2458.6**	**17628454.6**	**6952207.6**	**61**

AVGWLF Transport File and Model Output for East Branch Rausch Creek



Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	1	75	0.18	0.34440	0.03	0.45
CROPLAND	38	82	0.17578	3.36924	0.21	0.52
CONIF_FOR	10	73	0.172	2.03052	0.002	0.52
MIXED_FOR	26	73	0.17769	3.59572	0.002	0.52
DECID_FOR	789	73	0.17666	24.7691	0.002	0.52
QUARRY	110	89	0.17472	9.23142	0.8	0.8
COAL_MINES	14	87	0.17375	6.63194	0.8	0.8

Urban LU	Area (ha)	CN	K	LS	C	P
HI_INT_DEV	7	93	0.17714	3.4849	0.2	0.2

Month	ET	Day Hrs	Season	Eros Coef
APR	0.1491	13	0	0.301
MAY	0.6164	14	1	0.301
JUN	0.9085	15	1	0.301
JUL	1.0911	15	1	0.301
AUG	1.2061	14	1	0.301
SEP	1.2764	12	1	0.120
OCT	0.8598	11	0	0.120
NOV	0.5993	10	0	0.120
DEC	0.4365	9	0	0.120
JAN	0.0991	9	0	0.120
FEB	0.1239	10	0	0.120
MAR	0.1394	12	0	0.120

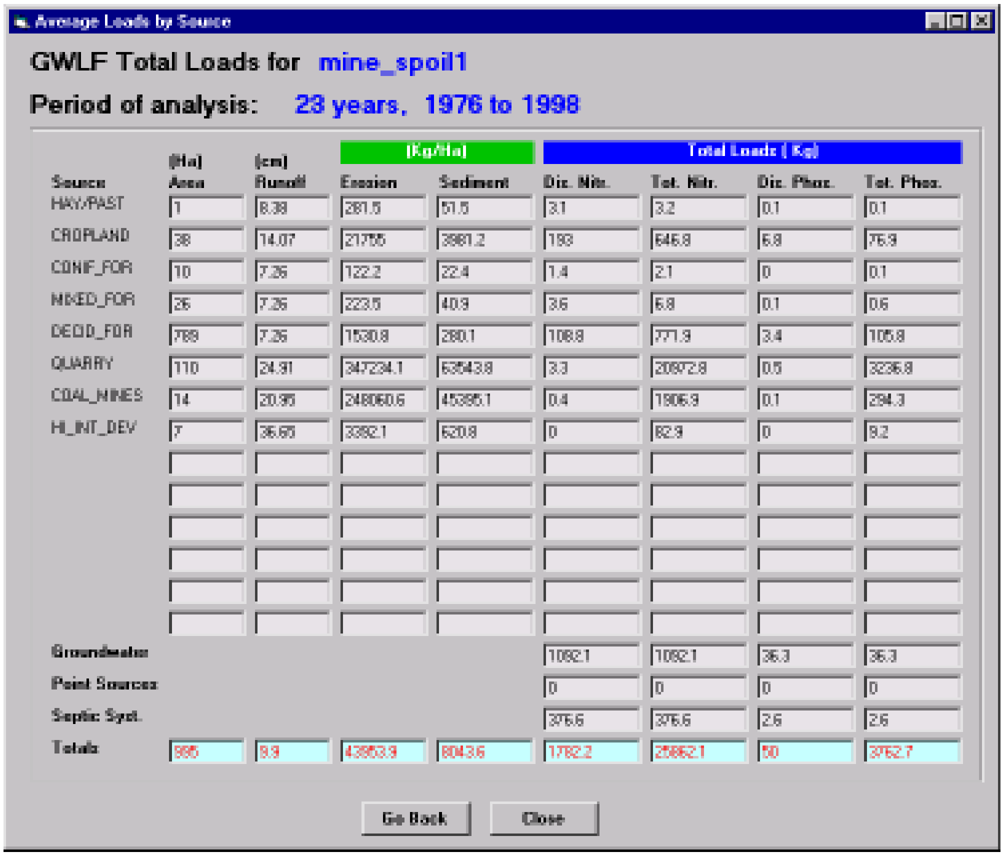
Antecedent Moisture Condition

Day -1	Day -2	Day -3	Day -4	Day -5
0	0	0	0	0

Init Unsat Stor (cm): 10
Init Sat Stor (cm): 0
Recess Coef (1/day): 0.10065
Seepage Coef (1/day): 0
Initial Snow (cm): 0
Sed Del Ratio: 0.183
Unsat Avail Wat (cm): 4.61471

D:\
TEMP
amd
mine_spoil
transedit1.dat

Load Transport File | Save Changes | Close



Average Loads by Source

GWLF Total Loads for mine_spoil1

Period of analysis: 23 years, 1976 to 1998

Source	(Ha) Area	(cm) Runoff	(Kg/Ha) Erosion	Sediment	Total Loads (Kg) Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	1	8.38	281.5	51.5	3.1	3.2	0.1	0.1
CROPLAND	38	14.07	21755	3981.2	193	646.8	6.8	76.9
CONIF_FOR	10	7.26	122.2	22.4	1.4	2.1	0	0.1
MIXED_FOR	26	7.26	223.5	40.9	3.6	6.8	0.1	0.6
DECID_FOR	789	7.26	1530.8	280.1	108.8	771.9	3.4	105.8
QUARRY	110	24.91	347234.1	63543.8	3.3	20972.8	0.5	3236.8
COAL_MINES	14	20.95	248060.6	45395.1	0.4	1906.9	0.1	294.3
HI_INT_DEV	7	36.65	3392.1	620.8	0	82.9	0	9.2
Groundwater					1092.1	1092.1	36.3	36.3
Point Sources					0	0	0	0
Septic Syst.					376.6	376.6	2.6	2.6
Totals	995	9.9	43953.9	8043.6	1782.2	25862.1	50	3762.7

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AVGWLF Transport File and Model Output for West Branch Rausch Creek

Edit Transport File

Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	2	75	0.18	5.68407	0.03	0
CROPLAND	12	82	0.17583	8.38042	0.21	0.74
CONIF_FOR	7	73	0.17428	2.59974	0.002	0.52
MIXED_FOR	47	73	0.17468	6.08389	0.002	0.52
DECID_FOR	1076	73	0.17586	54.3398	0.002	0.66
UNPAVED_RD	3	87	0.17581	2.88335	0.8	1
QUARRY	47	89	0.17468	10.6383	0.8	0.8
COAL_MINES	4	87	0.17583	2.27394	0.8	0.8

Urban LU	Area (ha)	CN	K	LS	C	P

Month	ET	Day Hrs	Season	Eros Coef
APR	0.1162	13	0	0.302
MAY	0.6657	14	1	0.302
JUN	1.0081	15	1	0.302
JUL	1.2238	15	1	0.302
AUG	1.3579	14	1	0.302
SEP	1.4418	12	1	0.121
OCT	0.9494	11	0	0.121
NOV	0.6417	10	0	0.121
DEC	0.4493	9	0	0.121
JAN	0.0772	9	0	0.121
FEB	0.0966	10	0	0.121
MAR	0.1086	12	0	0.121

Antecedent Moisture Condition

Day -1	Day -2	Day -3	Day -4	Day -5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0
Init Sat Stor (cm)	0	Sed Del Ratio	0.182
Recess Coef (l/day)	0.10087	Unsat Avail Wat (cm)	3.95547
Seepage Coef (l/day)	0		

D:\
TEMP
amd
mine_spoil_ref

transedit1.dat

Load Transport File | Save Changes | Close

Average Loads by Source

GWLF Total Loads for mine_spoil_ref

Period of analysis: 22 years, 1977 to 1998

Source	(Ha) Area	(cm) Runoff	(Kg/Ha) Erosion	Sediment	Total Loads (Kg) Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	2	7.52	0	0	4.7	4.7	0.2	0.2
CROPLAND	12	13.03	71323.1	12980.8	49.9	517.2	1.9	70.9
CONIF_FOR	7	6.43	146.7	26.7	0.9	1.4	0	0.1
MIXED_FOR	47	6.43	344.1	62.6	5.7	14.6	0.2	1.5
DECID_FOR	1076	6.43	3927.7	714.8	131.5	2439	4.2	344.9
UNPAVED_RD	3	19.83	126271.9	22981.5	17.3	224.1	1.2	31.7
QUARRY	47	23.79	370302.6	67395.1	1.3	9504	0.2	1403.4
COAL_MINES	4	19.83	79674.3	14500.7	0.1	174.1	0	25.7
Groundwater					984	984	44.9	44.9
Point Sources					0	0	0	0
Septic Syst.					591.7	591.7	3.4	3.4
Totals	1198	7.3	19366.5	3524.7	1787.1	14454.8	56.2	1926.8

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Attachment G

Comment and Response Summary

Commentor: USEPA Region 3

Comment:

The Rausch Creek Watershed is comprised of three water quality-limited segments, Rausch Creek, East Branch Rausch Creek, and West Branch Rausch Creek. Each segment must meet water quality standards within the section 303(d) listed segment. The siting of the AMD treatment plant was based on the best option for treating the contaminated stream flow, not based on protecting (or attaining water quality standards) in each section 303(d) listed segment. Because of the discussions regarding the water treatment plant near the mouth of Rausch Creek, it is unclear whether or not the discussion in the "Recommendations" section day lighting a mine pool is intended to address all mine pools. Please expand the Recommendations section to indicate that water quality standards can be met in the section 303(d) listed segments.

Response:

The following paragraph has been added to the recommendations section. "For both the East and West branches of Rausch Creek the opportunities to reduce or eliminate the flow coming from mine pools will be explored. A combination of the above mentioned activities may result in decreased flows from the mine pools and provide a large reduction in the mine drainage affects in these streams."

Comment:

This TMDL properly allocates a portion of the allowable loads to the permitted point sources. However, it should be noted that the calculated waste load allocation (WLA) is compared to the long-term allocation (LTA) calculated for the instream monitoring point. The permitted limits for iron and manganese are given as 6 and 4 mg/l respectively. It is assumed that these are the maximum daily limit (MDL) associated with technology based-limits for the coal mining industry. The associated average monthly limit (AML) would then be 3 and 2 mg/l, respectively, for iron and manganese. EPA concurs that it is not necessary to reduce the permittees' alloctions. However, converting the technology based-limits to water quality-based limits results in a slight numerical change. Using the procedure in *Technical Support Document for Water Quality-based Toxics Control,* March 1991, and assuming maintaining the AML is more important than maintaining the MDL, the following procedure is recommended:

Response:

Because these discharges are intermittent, small volume and make up such a small portion of the total loading in these watersheds we felt that using the maximum daily loading allowed in the permit coupled with the estimated discharge flow and duration was the most appropropriate method for evaluation. Also included in both WLA sections for both the East and West Branches is the following sentence: "If it is determined that is an increase in discharge flow we may re-evaluate this wasteload allocation."