LITTLE MUDDY RUN WATERSHED TMDL

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INTRODUCTION

This Total Maximum Daily Load (TMDL) calculation has been prepared for segments in the Little Muddy Run Watershed, including the East Branch Little Muddy Run Watershed. It was done to address the impairments noted in the 1996, 1998, and 2000 Pennsylvania 305(b) report, required under the Clean Water Act, and covers nine segments on the 1996, 1998, and draft 2000 303(d) lists (Table 1). The causes of these impairments are high levels of metals and low pH, with the source of the impairments being acid mine drainage (AMD). The TMDL addresses metals (iron, manganese, and aluminum) and low pH associated with AMD.

Table 1. Little Muddy Run Segments Addressed

State Water Plan (SWP) Subbasin 08-C: Clearfield Creek Basin

Year	*Miles*	*Segment ID*	*DEP Stream Code*	*Stream Name*	*Designated Use*	*Data Source*	*EPA 305(b) Source Code*	*EPA 305(b) Cause Code*
1996	4.5	7175	26246	Little Muddy Run	HQ-CWF source to Janesville Dam; CWF Janesville Dam to mouth	305(b) Report	RE	pH
1998	18.85	7175	26246	Little Muddy Run	HQ-CWF source to Janesville Dam; CWF Janesville Dam to mouth	SWMP	AMD	pH
2000	5.07	990102-0800-TVP	26246	Little Muddy Run	HQ-CWF source to Janesville Dam; CWF Janesville Dam to mouth	SWMP	AMD	Metals pH
2000	1.57	7175	26247	Little Muddy Run, Unt	CWF	SWMP	AMD	pH
2000	1.67	7175	26248	Little Muddy Run, Unt	CWF	SWMP	AMD	pH
2000	0.39	7175	26249	Little Muddy Run, Unt	CWF	SWMP	AMD	pH
2000	0.95	990102-0800-TVP	26255	Little Muddy Run, Unt	CWF	SWMP	AMD	Metals pH
1998	2.38	7175	26250	East Branch Little Muddy Run	CWF	SWMP	AMD	pH
2000	1.92	7175	26250	East Branch Little Muddy Run	CWF	SWMP	AMD	pH
2000	0.46	7175	26251	East Branch Little Muddy Run, Unt	CWF	SWMP	AMD	pH

HQ = High Quality Water
CWF = Cold Water Fishes
RE = Resource Extraction
SWMP = Surface Water Monitoring Program

AMD = Abandoned Mine Drainage

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 LITTLE MUDDY RUN WATERSHED

Little Muddy Run, a 14.5-square-mile watershed, is located in the Muddy Run Watershed in Clearfield and Cambria Counties, Pennsylvania (Attachment B). It is located approximately 28 miles southwest of State College, Pennsylvania, and approximately 4 miles southwest of the town of Houtzdale, Pennsylvania. Little Muddy Run can be accessed by traveling State Highway 53 southeast from the U.S. Route 322/State Route 53 interchange in Phillipsburg, Pennsylvania.

SEGMENTS ADDRESSED IN THIS TMDL

There are active mining operations in the watershed [Beth Contracting Beth #3 (Mining Permit #17910129); Beth Contracting Ramey #2 (Mining Permit #17980113)]; however, neither of them produces a discharge. The one large discharge in the watershed is from an abandoned mining operation and will be treated as a nonpoint source. The distinction between point and nonpoint sources 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. Each segment on the 303(d) list will be addressed as a separate TMDL. The TMDL for the listed segments 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 use designations for the stream segments in this TMDL can be found in Pennsylvania Title 25, Chapter 93.

WATERSHED BACKGROUND

Little Muddy Run, a 14.5-square-mile watershed, is located in the Muddy Run Watershed in Clearfield and Cambria Counties, Pennsylvania (Attachment B). It is located approximately 28 miles southwest of State College, Pennsylvania, and approximately 4 miles southwest of the town of Houtzdale, Pennsylvania. It flows through the eastern edge of the Main Bituminous Coalfield in central and western Pennsylvania. The bituminous coal region is characterized by strip and drift mining of coal seams that are horizontal in orientation; this often resulted in fairly level underground tunnels running for miles as coal was mined along a particular seam. After the mine workings had been abandoned, the tunnels often collapsed, filled up with water, and some discharged to the surface. Many of these tunnel discharges are very large and are responsible for much of the water quality impairment in the region. Large areas of the watershed were mined by multiple mining companies during a period from 1970 to the present (Attachment C). There are two active mining permits in the watershed and one additional permit application pending.

The headwaters of Little Muddy Run flow through State Game Lands No. 158. A Boy Scout Camp, Camp Waupsannock, is located in this area of the watershed. The camp uses springs as its drinking water supply; these springs are of good quality and not impacted by AMD. Little Muddy Run is attaining its designated uses in this section of the watershed. It is stocked yearly with brook trout by the Pennsylvania Fish and Boat Commission (PFBC) in the reach of stream from the Janesville Dam (near the town of Janesville) to the headwaters (Hollender 1995). One abandoned mine discharge used to flow into Little Muddy Run via a tributary locally called Comfort Run (tributary containing point UNT1 in Attachment B). However, a dewatering project was completed in the early 1990's to reroute a large amount of surface discharge from Comfort Run to the Viola #1 Mine Pool, thus preventing it from discharging to the surface and subsequently into Little Muddy Run (Pennsylvania Department of Environmental Resources 1986b, 1988).

The Janesville Dam is located in the mid-reaches of Little Muddy Run. The impoundment that the dam creates was drained in the 1980's due to the affects of AMD. It has since been refilled and now is stocked with brook trout by the PFBC (Hollender 1995). The dam creates a small impoundment used for recreational purposes (non-motorized boating, fishing, picnicking). Water leaves the impoundment over the dam, a concrete top-flow structure approximately 5 meters high. Below the Janesville Dam, Little Muddy Run widens and flattens out into a small valley. This section of the watershed is marshy and resembles a large wetland. One side of the valley is flanked by an old railroad bed that is used as a Rails-to-Trails path. According to historical records, many small discharges enter Little Muddy Run along this railroad bed. These discharges have not been monitored in the past and, therefore, no data are available for them. Little Muddy Run merges with East Branch Little Muddy Run in its lower reaches. The one abandoned mine discharge contributing to the impairment of Little Muddy Run in its lower reaches is the Brookwood Shaft. It joins with Little Muddy Run in the wetland area of the watershed and, although its effects are apparent (iron hydroxide precipitates on the stream bottom), the source is diffuse and difficult to locate.

Many studies have been conducted to assess the biological community present in Little Muddy Run. A Biological/Chemical Stream Survey conducted in 1989 on Little Muddy Run by the Pennsylvania Department of Environmental Resources (Pa. DER), now Department of Environmental Protection (Pa. DEP), Bureau of Mining and Reclamation found that the macroinvertebrate community was depressed at all sites downstream of the confluence of Little Muddy Run and Comfort Run (Baker 1989). Slight recovery was found below the Janesville Dam in comparison to other sites on Little Muddy Run. However, the macroinvertebrate recovery was not to the level of a site located above the confluence of Little Muddy Run and Comfort Run. The PFBC has stocked Little Muddy Run with brook trout since 1972. Degradation of stream conditions from an abandoned mine discharge in Comfort Run led the PFBC to discontinue stocking of trout in Little Muddy Run from 1986 to 1995. Remediation of AMD was conducted in the upper reaches of Little Muddy Run and brook trout were stocked again in 1996 (Hollender 1995).

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 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, 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 daily concentrations. These long-term average daily 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 evaluated in this TMDL are specified as total recoverable. Pennsylvania does have dissolved criteria for iron; however, the data used for this analysis report iron as total recoverable. Table 2 shows the water quality criteria for the selected parameters.

Table 2. Applicable Water Quality Criteria

Parameter	Criterion Value (mg/l)	Duration	Total Recoverable/ Dissolved
Iron (Fe)	1.50 0.3	1 day average Maximum	Total Recoverable Dissolved
Manganese (Mn)	1.00	Maximum	Total Recoverable
Aluminum (Al)*	0.1 of the 96 hour LC-50 0.75	Maximum One Hour	Total Recoverable
pH **	6.0-9.0	At all times	N/A

*This TMDL was developed using the value of 0.75 mg/l as the instream criteria 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 of the 96-hour LC-50 (the concentration of aluminum in test waters that is lethal to 50 percent of the test organisms during continuous exposure for 96 hours) and is contained in Pennsylvania Title 25, Chapter 93. The USEPA 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 (PFBC).

COMPUTATIONAL METHODOLOGY

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 indicates that there is no single critical flow condition for pollutant sources, and further, that there is no significant correlation between source flows and pollutant concentrations. The following table shows the correlation coefficients for sample points with greater than 15 samples (Table 3).

Table 3. Correlation Coefficients for Flow Versus Concentration of Metals				
Point Identification	***Flow vs.***			***Number of Samples***
	Iron	**Manganese**	**Aluminum**	
LMR1	0.128	0.107	0.006	29
LMR2	0.336	0.374	0.026	15
LMR3	0.112	0.553	0.005	31,19,18
LMR4	0.003	0.010	0.066	116,116,23
EB1	0.007	0.147	0.076	44
UNT2	0.056	0.103	0.003	44
LMR5	0.000	0.005	0.150	62,62,22

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, load allocations, and waste 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 the water quality criteria would be met instream at least 99 percent of the time. For each iteration, the required percent reduction is:

$$PR = \text{maximum } \{0, (1-Cc/Cd)\} \quad \text{where} \quad (1)$$

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

$$Cd = \text{RiskLognorm(Mean, Standard Deviation)} \quad \text{where} \quad (1a)$$

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 5,000 iterations, so that the allowable long-term average (LTA) concentration is:

$$LTA = Mean * (1 - PR99) \quad \text{where} \quad (2)$$

LTA = allowable LTA source concentration in mg/l

[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 was 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. The second series of simulations combined the flows and loads from individuals sources in a step-wise fashion, so that the level of attainment could be determined immediately downstream of each source. The pollutant-source flows used were the average flows measured at each loading point.

In general, these cumulative impact evaluations indicate that if the percent reductions determined during the first step of the analysis are achieved, then 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 above is contained in the TMDLs by segment 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 used to determine flow for points LMR4 were only those flow values from 1993 to the present. These values were used because a reclamation project had been constructed in the Comfort Run Watershed and had changed hydrologic conditions at point UNT1 and all points downstream. All flow measurements were determined using the mean of the flow values available for that point in the stream.

Data for the LMR1, LMR2, and LMR3 points did not include measurements of flow where they were taken. Flow determinations were made at these points using LMR4 as the basis for computing flow at these points. ArcView v3.2 was used to delineate the watersheds and determine watershed areas upstream of the points. The flow at the points and the watershed areas upstream of LMR4 and the points were used to compute the flow at LMR4 using the following equation:

$$\frac{\text{Flow LMR4}}{\text{Watershed Area LMR4}} = \frac{\text{Flow X}}{\text{Watershed Area X}} \qquad (3)$$

Table 4. Flow Determination for Loading Points in Little Muddy Run Watershed

Point Identification	*Average Flow (mgd*)*	*Determination Method*	*Number of Samples*	*Date Range*
UNT1 (mouth Comfort Run)	0.185	Unit-area		
LMR1 (in headwaters)	0.860	Unit-area		
LMR2	1.08	Unit-area		
LMR3 (above Janesville Dam)	1.55	Unit-area		
LMR4 (below Janesville Dam)	1.83	Average	11	1993-1997
EB1 (East Branch mouth)	0.490	Average	44	1989-1997
UNT2	0.242	Average	44	1989-1997

LMR5 (near confluence with Muddy Run)	3.33**	Unit-area		

*mgd = million gallons per day

**Although an average flow was available at point LMR5 using data from 1993-present, the value was not used. A decision based on best professional judgment was made that there were too few measurements (3) to adequately represent the actual average flow occurring at point LMR5.

TMDLS BY SEGMENT

Little Muddy Run above LMR1

Little Muddy Run above point LMR1 is attaining its designated uses and is, therefore, not included on the 303(d) list. Because the reach of Little Muddy Run containing LMR1 is not listed as impaired, a TMDL will not be done for Little Muddy Run upstream of LMR1.

Unnamed Tributary to Little Muddy Run (Comfort Run)

The unnamed tributary to Little Muddy Run between points LMR1 and LMR2 is locally called Comfort Run. Comfort Run, above point UNT1, was affected by AMD from an abandoned discharge (Viola Mine Discharge) until the early 1990's. The discharge was found to be entering Comfort Run as an artesian discharge into the streambed. In 1993, a pipeline system was built to dewater the discharge by diverting it into an underground mine pool to prevent the AMD from entering Comfort Run. The Viola Mine Discharge no longer has a large effect on Comfort Run. However, it is possible that other small discharges exist in the Comfort Run Watershed that are causing impairment to Comfort Run and Little Muddy Run. More study would be necessary to determine if there were another source of AMD in Comfort Run.

The TMDL for Comfort Run consists of a load allocation to all of the watershed area above point UNT1 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was not available for point UNT1; the average flow was derived using the unit-area method (0.185 mgd).

No data were available for point UNT1 for alkalinity or acidity; therefore, pH impairment is not addressed at this sample point.

An allowable long-term average instream concentration was determined at point UNT1 for iron, manganese, and aluminum. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point UNT1 for this stream segment are presented in Table 5.

Table 5. Reductions for Comfort Run Above UNT1						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
UNT1	Fe	8.33	12.9	0.33	0.51	96
	Mn	5.28	8.1	0.26	0.40	95
	Al	0.53	0.8	0.29	0.45	45

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

The TMDL for Comfort Run at point UNT1 requires that a load allocation be made for all areas above UNT1 for total iron, total manganese, and total aluminum.

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 used represent 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 unit-area flow was used to derive loading values for the TMDL.

Little Muddy Run Between Points LMR1 and LMR2

Little Muddy Run between points LMR1 and LMR2 represents Little Muddy Run after receiving water from Comfort Run. Although the effects of the Viola Mine Discharge have been remediated, it is possible that other small discharges exist in the Comfort Run Watershed that are impairing Little Muddy Run. More study would be necessary to determine the source of the AMD.

The TMDL for this section of Little Muddy Run consists of a load allocation to all of the watershed area above point LMR2 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point LMR2 (1.08 mgd).

Sample data for point LMR2 show pH ranging from 6.2 to 6.9, with an average pH of 6.43. The pH impairment will not be addressed at this point as part of this TMDL because the data show that point LMR2 is net alkaline and is meeting water quality criteria for pH (Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration was determined at point LMR2 for iron, manganese, and aluminum. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point LMR2 for this stream segment are presented in Table 6.

Table 6. Reductions for Little Muddy Run Between LMR1 and LMR2

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
LMR2	Fe	0.34	3.1	0.30	2.7	12
	Mn	0.29	2.6	0.11	1.0	60
	Al	0.26	2.3	0.17	1.5	36
	Acidity	4.18	37.7	NA	NA	NA
	Alkalinity	8.91	80.3			

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

The TMDL for Little Muddy Run at point LMR2 requires that a load allocation be made for all areas between LMR 1 and LMR2 for total iron, total manganese, and total aluminum.

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 used represent 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 unit-area flow was used to derive loading values for the TMDL.

Little Muddy Run Between LMR2 and LMR3

Little Muddy Run between points LMR2 and LMR3 drains one unnamed tributary to Little Muddy Run. This unnamed tributary is not impaired due to AMD and, therefore, is not listed on the 303(d) list. This section of Little Muddy Run represents the reach from point LMR2 to above the Janesville Dam (LMR3).

The TMDL for this section of Little Muddy Run consists of a load allocation to all of the watershed area above point LMR3 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was not available for point LMR3; the average flow was derived using the unit-area method (1.55 mgd).

Sample data for point LMR3 show pH ranging from 5.7 to 6.5, with an average pH of 6.17. The pH impairment will not be addressed at this point as part of this TMDL because of a lack of alkalinity and acidity data and the pH data show that point LMR3 is meeting water quality criteria for pH (Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, and aluminum was determined at point LMR3. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point LMR3 for this stream segment are presented in Table 7.

Table 7. Long Term Average (LTA) Concentrations for Little Muddy Run Between LMR2 and LMR3

Station	*Parameter*	*Measured Sample Data*		*Allowable*	
		Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*
LMR3	Fe	0.74	9.6	0.29	3.7
	Mn	0.91	11.7	0.36	4.6
	Al	0.25	3.2	0.20	2.6

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

The loading reductions for point LMR2 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point LMR3. This value was compared to the allowable load at point LMR3. Reductions at point LMR3 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point LMR3 are shown in Table 8. Necessary reductions at point LMR3 are shown in Table 9.

Table 8. Summary of Loads Affecting Point LMR3			
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***
LMR2			
Existing Load	3.1	2.6	2.3
Allowable Load	2.7	1.0	1.5
Load Reduction	0.4	1.6	0.8

Table 9. Reductions Necessary at Point LMR3			
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***
Existing Loads at LMR3	9.6	11.7	3.2
Total Load Reduction (LMR2)	0.4	1.6	0.8
Remaining Load	9.2	10.1	2.4
Allowable Loads at LMR3	3.7	4.6	2.6
Percent Reduction	60	54	0

The TMDL for Little Muddy Run at point LMR3 requires that a load allocation be made for all areas between LMR2 and LMR3 for total iron and total manganese.

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 used represent 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 unit-area flow was used to derive loading values for the TMDL.

Little Muddy Run Between LMR3 and LMR4

The Janesville Dam is located between point LMR3 and LMR4. No abandoned mine discharges drain into Little Muddy Run in this reach of stream.

The TMDL for this section of Little Muddy Run consists of a load allocation to all of the watershed area above point LMR4 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point LMR4 (1.83 mgd).

Sample data for point LMR4 show pH ranging from 4.6 to 7.5, with an average pH of 6.19. The pH impairment will be addressed at this point as part of this TMDL because the 99th percentile from Monte Carlo analysis shows that point LMR4 is net acidic and is not meeting water quality criteria for pH (Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, and aluminum was determined at point LMR4. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point LMR4 for this stream segment are presented in Table 10.

Table 10. Long-Term Average (LTA) Concentrations for Little Muddy Run Between LMR3 and LMR4

Station	***Parameter***	***Measured Sample Data***		***Allowable***	
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
LMR4	Fe	1.58	24.1	0.14	2.1
	Mn	0.81	12.4	0.11	1.7
	Al	0.38	5.8	0.15	2.3
	Acidity	3.68	56.2	1.52	23.2
	Alkalinity	16.14	246.3		

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

The loading reductions for point LMR3 were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point LMR4. This value was compared to the allowable load at point LMR4. Reductions at point LMR4 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point LMR4 are shown in Table 11. Necessary reductions at point LMR4 are shown in Table 12.

Table 11. Summary of Loads Affecting Point LMR4

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***
LMR3			
Existing Load	9.6	11.7	3.2
Allowable Load	3.7	4.6	2.6
Load Reduction	5.9	7.1	0.6

The load allocation for this stream segment was computed using water-quality sample data collected at point LMR4 and the allowable loads from LMR3. The average flow, measured at sample point LMR4, is used for these computations. The percent reduction is calculated as follows (Table 12):

$$\left[1-\left(\frac{\text{Allowable Loads at LMR4}}{\text{Remaining Load (Existing Loads at LMR4 - TLR Sum LMR3}}\right)\right]\times 100\,\%$$

Table 12. Reductions Necessary at Point LMR4

	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at MR4	24.1	12.4	5.8	56.2
Total Load Reduction (LMR3)	5.9	7.1	0.6	NA
Remaining Load	18.2	5.3	5.2	56.2
Allowable Loads at LMR4	2.1	1.7	2.3	23.2
Percent Reduction	89	68	56	59

The TMDL for point LMR4 requires that a load allocation be applied to all areas of Little Muddy Run between LMR3 and LMR4 for total iron, total manganese, and total aluminum.

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 used represent 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 was used to derive loading values for the TMDL.

East Branch Little Muddy Run Above EB1

East Branch Little Muddy Run above point EB1 contains no additional mine discharges. The East Branch mainstem and one unnamed tributary are listed on the 303(d) list as being pH impaired. The source of the impairment is likely a small, diffuse seep but more study would be necessary. A permit is pending in the East Branch Little Muddy Run Watershed for a strip-mining operation [Hilltop Coal Company, Inc. (Mining Permit # 17000105)].

The proposed permit encompasses 48 acres (16 acres of coal removal), which is representative of a small mining operation and is expected to produce a very low volume discharge. This will be an intermittent discharge. The only discharge expected from this site will result from rainwater being pumped from the pit area, which goes to the treatment ponds and is released to the stream and sediment ponds that are not contaminated with AMD. If it is determined that discharge volumes increase or the loading is greater than the projected 15% increase accounted for in the calculations, the TMDL may need re-evaluated.

The TMDL for East Branch Little Muddy Run consists of a load allocation to all of the watershed area above point EB1 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point EB1 (0.490 mgd).

Sample data for point EB1 show pH ranging from 6.0 to 8.3, with an average pH of 6.93. The pH impairment will not be addressed at this point as part of this TMDL because the data show that point EB1 is net alkaline and is meeting water quality criteria for pH (Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, and aluminum was determined at point EB1. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point EB1 for this stream segment are presented in Table 13.

Table 13. Reductions for East Branch Little Muddy Run Above EB1

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
EB1	Fe	0.18	0.7	0.18	0.7	0
	Mn	0.14	0.6	0.14	0.6	0
	Al	0.24	1.0	0.16	0.7	34
	Acidity	0.22	0.9	NA	NA	NA
	Alkalinity	28.65	117.1			

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

The TMDL for point EB1 requires that a load allocation be applied to all areas of East Branch Little Muddy Run above EB1 for total aluminum.

A permit is pending in the East Branch Little Muddy Run Watershed. A fifteen percent increase in all concentrations was calculated to determine the reductions necessary to meet water quality standards in the future with the increase in concentration instream. The same procedure that was

followed to determine reductions without the 15 percent increase was followed. Table 14 shows the reductions necessary at point EB1 with a 15 percent increase in concentrations to allow for future mining activities.

Table 14. Reductions for East Branch Little Muddy Run Above EB1 With 15 Percent Increase For Future Mining

Station	*Parameter*	*Measured Sample Data*		*Allowable*		*Reduction Identified*
		Conc. (mg/l)	*Load (lb/day)*	*LTA Conc. (mg/l)*	*Load (lb/day)*	*Percent*
EB1+15%	Fe	0.20	0.8	0.20	0.8	0
	Mn	0.16	0.7	0.16	0.7	0
	Al	0.28	1.1	0.16	0.7	44
	Acidity	0.25	1.0	NA	NA	NA

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

The TMDL for point EB1+15% requires that a load allocation be applied to all areas of East Branch Little Muddy Run above EB1 for total aluminum.

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 used represent 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 was used to derive loading values for the TMDL.

Unnamed Tributary to Little Muddy Run Above UNT2

The unnamed tributary to Little Muddy Run above point UNT2 contains no additional abandoned mine discharges. Two active mining permits are located in this area of the watershed. Both permits are issued to Beth Contracting, Inc. (Mining Permit # 17980113, 17910129). Two unnamed tributaries to Little Muddy Run in this area are listed on the 303(d) list as being pH-impaired.

The TMDL for this section of unnamed tributary to Little Muddy Run consists of a load allocation to all of the watershed area above point UNT2 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point UNT2 (0.242 mgd).

Sample data for point UNT2 show pH ranging from 5.8 to 8.0, with an average pH of 6.89. The pH impairment will not be addressed at this point as part of this TMDL because the data show that point UNT2 is net alkaline and is meeting water quality criteria for pH (Table 2). The method and rationale for addressing pH is contained in Attachment C.

An allowable long-term average instream concentration for iron, manganese, and aluminum was determined at point UNT2. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point UNT2 for this stream segment are presented in Table 15.

Table 15. Reductions for the Unnamed Tributary to Little Muddy Run Above UNT2

Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***	***Percent***
UNT2	Fe	0.53	1.1	0.24	0.5	55
	Mn	0.65	1.3	0.13	0.3	80
	Al	0.19	0.4	0.11	0.2	39
	Acidity	0.98	2.0	NA	NA	NA
	Alkalinity	52.33	105.6			

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

The TMDL for point UNT2 requires that a load allocation be applied to all areas of the unnamed tributary to Little Muddy Run above UNT2 for total iron, total manganese, and total aluminum.

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 used represent 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 was used to derive loading values for the TMDL.

Little Muddy Run Between LMR4 and LMR5

Little Muddy Run between LMR4 and LMR5 receives flow from the East Branch Little Muddy Run and two unnamed tributaries to Little Muddy Run. One of these unnamed tributaries includes the point UNT2 and the other unnamed tributary includes drainage from the Brookwood Shaft Discharge. The Brookwood Shaft Discharge is presently the largest contributor to impairment in the Little Muddy Run Watershed. The watershed becomes wide and flat between points LMR4 and LMR5 and resembles a wetland. Because of the wetland characteristics of the lower watershed, the exact location of the Brookwood Shaft Discharge is difficult to find. The area near where the discharge is to be located is stained with iron hydroxide precipitates. However, the staining is apparent at multiple points in the wetland area which is altered by human activity and, therefore, it is difficult to pinpoint the exact location. Little Muddy Run downstream of the discharge is stained heavily with iron hydroxide precipitates to its confluence with Muddy Run. Point LMR5 is located near the confluence of Little Muddy Run and Muddy Run and represents the mouth of Little Muddy Run.

The pH impairment will be addressed at this point as part of this TMDL because the data show that point LMR5 is net acidic and is not meeting water quality criteria for pH (Table 2). The method and rationale for addressing pH is contained in Attachment C.

The TMDL for this section of Little Muddy Run consists of a load allocation to all of the watershed area above point LMR5 (Attachment B). Addressing the mining impacts above this point addresses the impairment for the segment. An instream flow measurement was available for point LMR5 (3.33 mgd).

An allowable long-term average instream concentration for iron, manganese, aluminum, and acidity was determined at point LMR5. The analysis is designed to produce a long-term average value that, when met, will be protective of the water quality criterion for that parameter 99 percent of the time. An analysis was performed using Monte Carlo simulation to determine the necessary long-term average concentration needed to attain water quality criteria 99 percent of the time. The simulation was run assuming the data set was lognormally distributed. Using the mean and the standard deviation of the data set, 5,000 iterations of sampling were completed and compare 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 that percent reduction times that sampled value was run to insure that criteria were met 99 percent of the time. The mean value from this data set represents that long-term daily average concentration that needs to be met to achieve water quality standards. The load allocations made at point LMR5 for this stream segment are presented in Table 16.

Table 16. Long-Term Average (LTA) Concentrations for Little Muddy Run Between LMR4 and LMR5					
Station	***Parameter***	***Measured Sample Data***		***Allowable***	
		Conc. (mg/l)	***Load (lb/day)***	***LTA Conc. (mg/l)***	***Load (lb/day)***
LMR5	Fe	7.46	207.2	0.30	8.3
	Mn	4.67	129.7	0.28	7.8
	Al	2.53	70.3	0.15	4.2
	Acidity	29.43	817.3	3.23	89.9
	Alkalinity	14.00	388.8		

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

The loading reductions for point LMR4, UNT2, and EB1 (a conservative estimate as opposed to EB+15% because it calls for a lower reduction) were used to show the total load that was removed from upstream sources. For each parameter, the total load that was removed upstream was subtracted from the existing load at point LMR5. This value was compared to the allowable load at point LMR5. Reductions at point LMR5 are necessary for any parameter that exceeds the allowable load at this point. A summary of all loads that affect point LMR5 are shown in Table 17. Necessary reductions at point LMR5 are shown in Table 18.

Table 17. Summary of Loads Affecting Point LMR5				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
LMR4				
Existing Load	24.1	12.4	5.8	56.2
Allowable Load	2.1	1.7	2.3	23.2
Load Reduction	22.0	10.7	3.5	33.0
UNT2				
Existing Load	1.1	1.3	0.4	NA
Allowable Load	0.5	0.3	0.2	NA
Load Reduction	0.6	1.0	0.2	NA
EB1				
Existing Load	0.7	0.6	1.0	NA
Allowable Load	0.7	0.6	0.7	NA
Load Reduction	0	0	0.3	NA

The load allocation for this stream segment was computed using water-quality sample data collected at point LMR5 and the allowable loads from LMR4, UNT2, and EB1. The average flow, determined by unit-area at sample point LMR5, is used for these computations. The percent reduction is calculated as follows (Table 18):

$$\left[1-\left(\frac{\text{Allowable Loads at LMR5}}{\text{Remaining Load (Existing Loads at LMR5 - TLR Sum LMR4, UNT2, EB1}}\right)\right]\times 100\,\%$$

Table 18. Reductions Necessary at Point LMR5				
	Iron (lb/day)	***Manganese (lb/day)***	***Aluminum (lb/day)***	***Acidity (lb/day)***
Existing Loads at LMR5	207.2	129.7	70.3	817.3
Total Load Reduction (LMR4, UNT2, EB1)	22.6	11.7	4.0	33.0
Remaining Load	184.6	118.0	66.3	784.3
Allowable Loads at LMR5	8.3	7.8	4.2	89.9
Percent Reduction	96	94	94	89

The TMDL for Little Muddy Run at point LMR5 requires that a load allocation be made for all areas between LMR4 and LMR5 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 used represent 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 unit-area flow was used to derive loading values for the TMDL.

SUMMARY OF ALLOCATIONS

This TMDL will focus remediation efforts on the identified numerical reduction targets for each watershed. As changes occur in the watershed, the TMDL may be re-evaluated to reflect current conditions. Table 19 presents the estimated reductions identified for all points in the watershed.

Table 19. Summary Table – Little Muddy Run Watershed

Station	*Parameter*	*Measured Sample Data*		*Allowable*		*Reduction Identified*
		Conc. (mg/l)	*Load (lbs/day)*	*LTA Conc. (mg/l)*	*Load (lbs/day)*	*Percent*
UNT1						
	Fe	8.33	12.9	0.33	0.51	96
	Mn	5.28	8.1	0.26	0.40	95
	Al	0.53	0.8	0.29	0.45	45
	Acidity	No data available.				
	Alkalinity	No data available.				
LMR2						
	Fe	0.34	3.1	0.30	2.7	12
	Mn	0.29	2.6	0.11	1.0	60
	Al	0.26	2.3	0.17	1.5	36
	Acidity	4.18	37.7	NA	NA	NA
	Alkalinity	8.91	80.3			
LMR3						
	Fe	0.74	9.6	0.29	3.7	60*
	Mn	0.91	11.7	0.36	4.6	54*
	Al	0.25	3.2	0.20	2.6	0*
	Acidity	No data available				NA*
	Alkalinity	No data available				
LMR4						
	Fe	1.58	24.1	0.14	2.1	89*
	Mn	0.81	12.4	0.11	1.7	68*
	Al	0.38	5.8	0.15	2.3	56*
	Acidity	3.68	56.2	1.52	23.2	59*
	Alkalinity	16.14	246.3			
EB1						
	Fe	0.18	0.7	0.18	0.7	0
	Mn	0.14	0.6	0.14	0.6	0
	Al	0.24	1.0	0.16	0.7	34
	Acidity	0.22	0.9	NA	NA	NA
	Alkalinity	28.65	117.1			
EB1+15%						
	Fe	0.20	0.8	0.20	0.8	0
	Mn	0.16	0.7	0.16	0.7	0
	Al	0.28	1.1	0.16	0.7	44
	Acidity	0.25	1.0	NA	NA	NA
UNT2						
	Fe	0.53	1.1	0.24	0.5	55
	Mn	0.65	1.3	0.13	0.3	80
	Al	0.19	0.4	0.11	0.2	39
	Acidity	0.98	2.0	NA	NA	NA
	Alkalinity	52.33	105.6			
LMR5						
	Fe	7.46	207.2	0.30	8.3	96*
	Mn	4.67	129.7	0.28	7.8	94*
	Al	2.53	70.3	0.15	4.2	94*

Table 19. Summary Table – Little Muddy Run Watershed						
Station	***Parameter***	***Measured Sample Data***		***Allowable***		***Reduction Identified***
		Conc. (mg/l)	***Load (lbs/day)***	***LTA Conc. (mg/l)***	***Load (lbs/day)***	***Percent***
	Acidity	29.43	817.3	3.23	89.9	89*
	Alkalinity	14.00	388.8			

* Summary data for percent reductions are found in the following tables: LMR3 – Table 9; LMR4 – Table 12; LMR5 – Table 18

RECOMMENDATIONS

The effects of Viola #1 Mine Discharge in the upper Little Muddy Run Watershed have been remediated by the dewatering project built in the early 1990's. The only other large discharge in the watershed is the Brookwood Shaft in the lower Little Muddy Run Watershed. A Growing Greener Grant Project entitled "Abandoned Mine Reclamation Project, Little Muddy Run North, Gulich Township, Clearfield County" was completed in 2000 (Contract No. OSM 17(7052)101.1). This project restored 17 acres of strip-mined land owned by Power Operating Company, Inc., for $237,594.65.

There is currently no community group in the Little Muddy Run Watershed area. It is recommended that agencies work with local interests to form a watershed organization. This watershed organization could then work to implement projects to achieve the reductions recommended in this TMDL document.

PUBLIC PARTICIPATION

Public notice of the draft TMDL was published in the *Pennsylvania Bulletin* and the *Centre Daily Times* on December 16, 2000, to foster public comment on the allowable loads calculated. A public meeting was held on January 11, 2001, at the Hawk Run District Mining Office in Phillipsburg, Pa., to discuss the proposed TMDL.

REFERENCES

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Pennsylvania Department of Environmental Resources. 1988. Unpublished. Implementation Plan, Passive Dewatering and Treatment Systems, Westport Site, Benjamin Coal Company.

Skelly and Loy, Engineers and Consultants. 1971. Muddy Run Watershed Mine Drainage Pollution Abatement Project. Project Report SL-155. Completed for the Pennsylvania Department of Environmental Resources.

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:

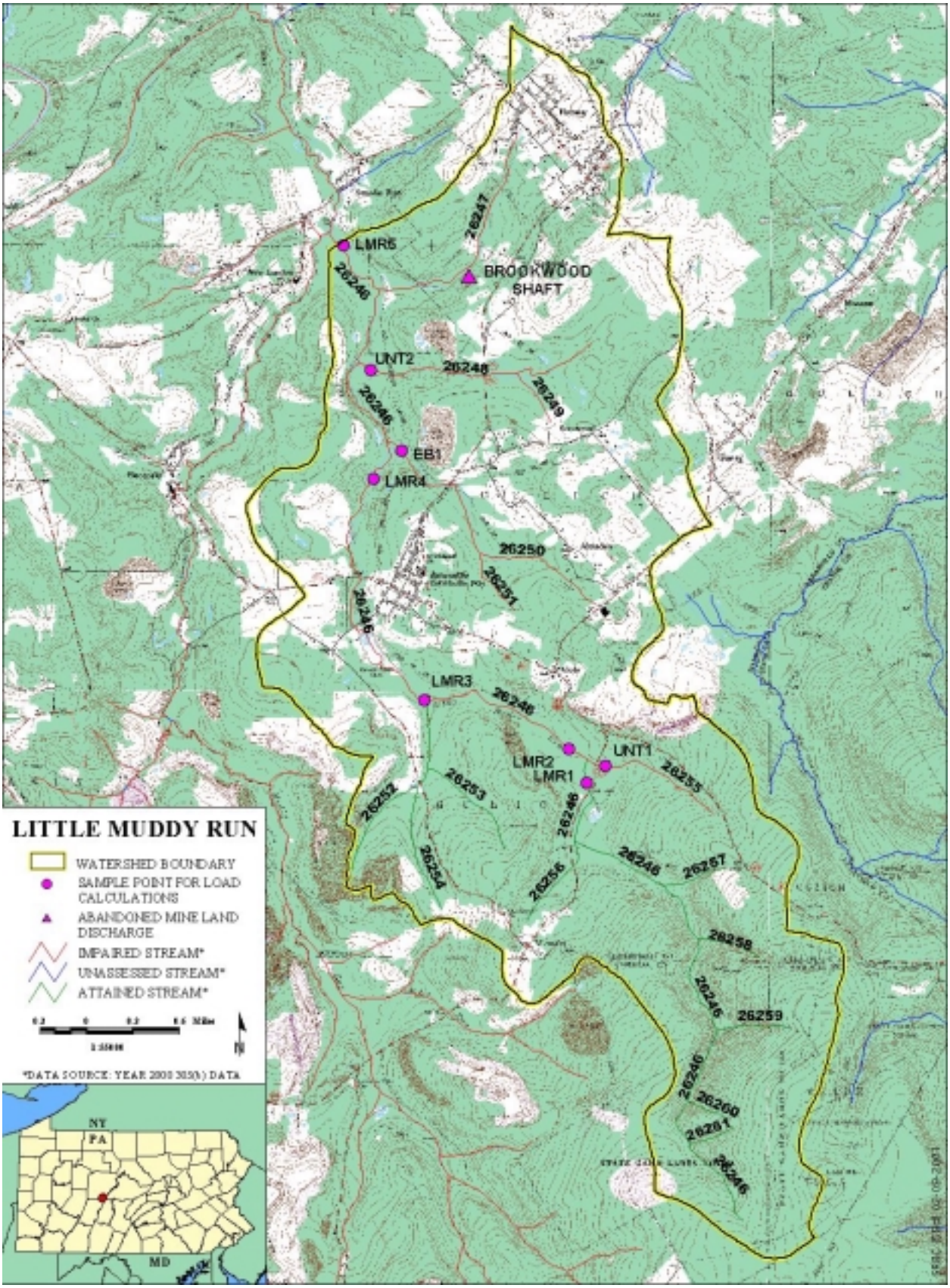
1. mileage differences due to recalculation of segment length by the GIS;
2. slight changes in source(s)/cause(s) due to new EPA codes;
3. changes to source(s)/cause(s), and/or miles due to revised assessments;
4. corrections of misnamed streams or streams placed in inappropriate SWP subbasins; and
5. 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

Little Muddy Run Watershed Map


LITTLE MUDDY RUN
WATERSHED BOUNDARY
SAMPLE POINT FOR LOAD CALCULATIONS
ABANDONED MINE LAND DISCHARGE
IMPAIRED STREAM*
UNASSESSED STREAM*
ATTAINED STREAM*
*DATA SOURCE: YEAR 2008 303(d) DATA
NY
PA
MD
LMR5
BROOKWOOD SHAFT
UNT2
EB1
LMR4
LMR3
LMR2
LMR1
UNT1
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Attachment C

Mining Permits in the Little Muddy Run Watershed

Permit Number	Company Name	Permit Status
17890113	C&K Coal Company (Cambria Coal)	Stage II Bond Release
17743061	C&K Coal Company (Cambria Coal)	Completed
17820101	C&K Coal Company (Cambria Coal)	Completed
17850113	Paul F. Becker Coal Company	Completed
1779132	Westport Mining Company	Completed
17910132	Sky Haven Coal, Inc.	Stage II Bond Release
1781013	Flango Brothers Coal, Inc.	Completed
4375SM9	Power Operating Company, Inc.	Completed
17980113	Beth Contracting, Inc.	Active
17910129	Beth Contracting, Inc.	Active
17000105	Hilltop Coal Company, Inc.	Pending

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[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 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

[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.

upper segments that are not impacted by mining activity. All other streams will be required to meet a minimum net alkalinity of zero.

Error may be introduced by the method of calculation shown above when waters have a pH > 6.0 and iron plus manganese is greater than 10 mg/L. Measured acidity may significantly underestimate the actual acidity. This condition is most likely to be experienced in a mine discharge that has not undergone oxidation, and would not be prevalent in a free flowing stream. Under these conditions the acidity should be both measured and calculated using the following formula:

$$\text{Calc. acidity, mg } CaCO_3/L = 50[(2Fe^{2+}/56) + (3Fe^{3+}/56) + (3Al/27) + 2Mn/55 + 1000(10^{-pH})]$$

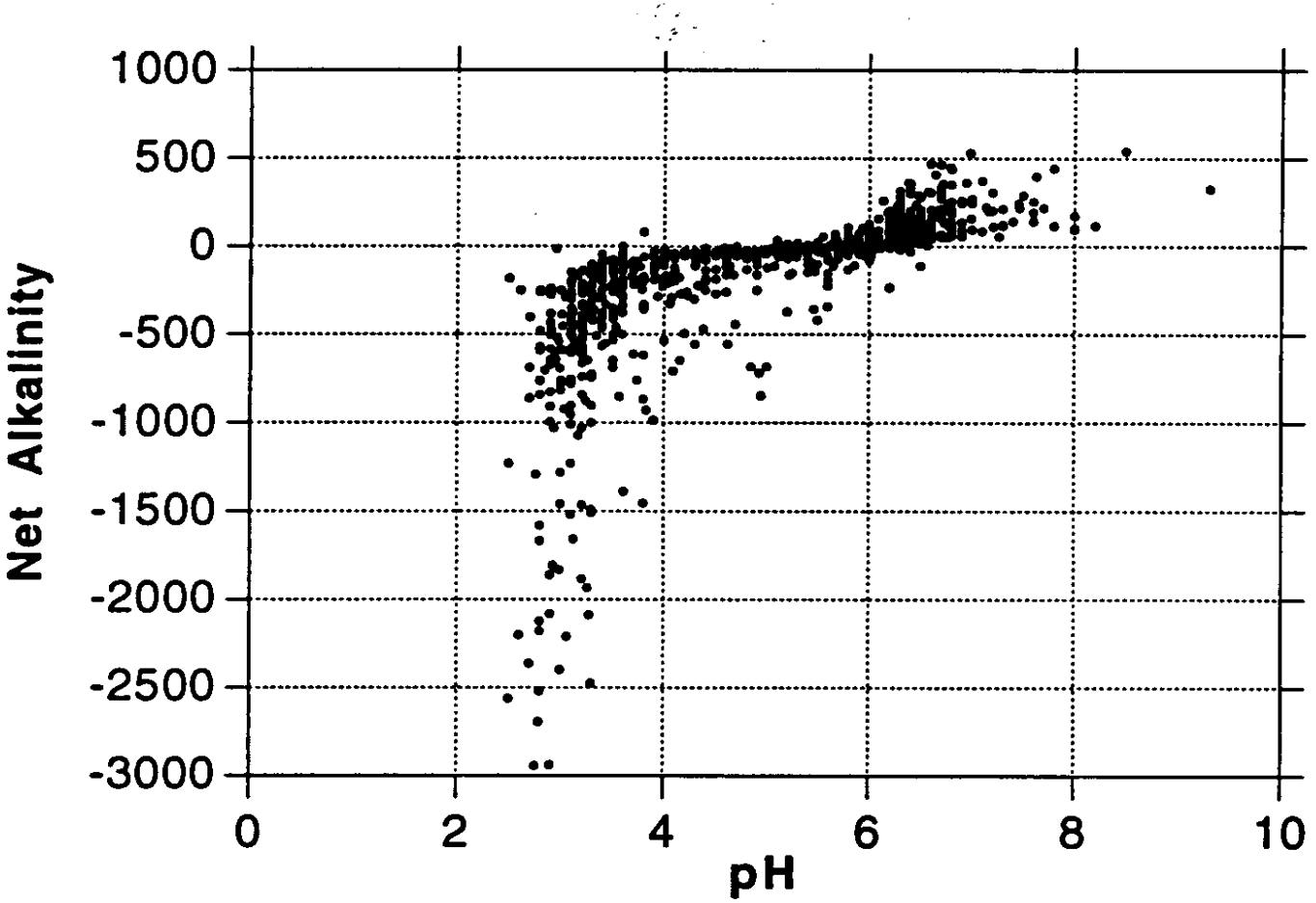

Figure 1. Net Alkalinity vs. pH. Taken from Figure 1.2 Graph C, pages 1-5, of Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

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):

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

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).

$$Q_{swat11} = Q_{swat}04 \times 0.142 + 0.088 \quad (2)$$

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

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

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 in 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):

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

This equation was simulated through 5,000 iterations, and the 99^{th} 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						
		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	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 Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
LMR1	Sample Pt 7	Westport Mining Company Study	1779132	6/19/70	619	0.1	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	7/30/70	2244	0.1	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	8/31/70	1589	0.2	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	9/30/70	916	0.2	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	10/29/70	1513	0.2	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	11/29/70	2531	0	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	12/12/70	5076	0	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	3/5/71	16516	0.06	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	3/23/71		0.45					
	Sample Pt 7	Westport Mining Company Study	1779132	4/8/71	9200	0.02	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	5/11/71	2477	0.1	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	6/22/71	3025	0.5	*	*	*	*	
	Sample Pt 7	Westport Mining Company Study	1779132	12/15/71		0.2					
	Sample Pt 7	Westport Mining Company Study	1779132	3/15/79		0.04	0.11				
	Sample Pt 7	Westport Mining Company Study	1779132	8/15/79		0.04	0.01	0.08			
	Sample Pt 7	Westport Mining Company Study	1779132	12/18/81		0.08	0.18				
	Sample Pt 7	Westport Mining Company Study	1779132	3/31/82		0.02	0.18				
	Sample Pt 7	Westport Mining Company Study	1779132	5/25/82		0.25	0.09				
	Sample Pt 7	Westport Mining Company Study	1779132	9/9/82		0.01	0.23				
	Sample Pt 7	Westport Mining Company Study	1779132	11/20/82		0.12	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	2/1/83	5000	0.39	0.07	0.16	0	15	
	Sample Pt 7	Westport Mining Company Study	1779132	2/25/83		0.03	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	3/2/83	15000	0.1	0.1	0.07	0	14	
	Sample Pt 7	Westport Mining Company Study	1779132	4/19/83		0.02					
	Sample Pt 7	Westport Mining Company Study	1779132	6/4/83	5356	0.1	0.1	0.15	0	12	
	Sample Pt 7	Westport Mining Company Study	1779132	7/12/83		0.01	0.01	0.06			
	Sample Pt 7	Westport Mining Company Study	1779132	8/15/83		0.03	0.29				
	Sample Pt 7	Westport Mining Company Study	1779132	12/10/83		0.01	0.29				
	Sample Pt 7	Westport Mining Company Study	1779132	1/7/84		0.01	0.15				
	Sample Pt 7	Westport Mining Company Study	1779132	2/6/84		0.02	0.14				
	Sample Pt 7	Westport Mining Company Study	1779132	5/25/84		0.01	0.15				
	Sample Pt 7	Westport Mining Company Study	1779132	6/4/84		0.1	0.05	0.15			
	Sample Pt 7	Westport Mining Company Study	1779132	7/12/84	2735	0.1	0.1	0.7	0	14	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Sample Pt 7	Westport Mining Company Study	1779132	7/26/84	1380	0.1	0.1	0.2	0	14	
	Sample Pt 7	Westport Mining Company Study	1779132	7/30/84		0.09	0.18	0.63			
	Sample Pt 7	Westport Mining Company Study	1779132	8/22/84	3938	0.1	0.1	0.1	0	14	
	Sample Pt 7	Westport Mining Company Study	1779132	9/6/84	1501	0.2	0.1	0.2	16	15	
	Sample Pt 7	Westport Mining Company Study	1779132	10/16/84	693	0.3	0.1	0.1	0	18	
	Sample Pt 7	Westport Mining Company Study	1779132	10/18/84		0.12	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	1/7/85		0.01	0.15				
	Sample Pt 7	Westport Mining Company Study	1779132	3/20/85	3558	0.3	0.1	0.1	*	18	
	Sample Pt 7	Westport Mining Company Study	1779132	4/29/85	*	0.01	0.01	0.02	0	14	
	Sample Pt 7	Westport Mining Company Study	1779132	5/15/85		0.01	0.06				
	Sample Pt 7	Westport Mining Company Study	1779132	7/29/85		0.01	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	9/12/85		0.11	0.01	0.83			
	Sample Pt 7	Westport Mining Company Study	1779132	10/14/85		0.01	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	2/7/86		0.01	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	3/4/86		0.06	0.02				
	Sample Pt 7	Westport Mining Company Study	1779132	3/16/86	5846	0.2	0.09	0.36	20	12	
	Sample Pt 7	Westport Mining Company Study	1779132	4/22/86		0.05	0.21				
	Sample Pt 7	Westport Mining Company Study	1779132	9/1/86		0.01	0.03				
	Sample Pt 7	Westport Mining Company Study	1779132	11/20/86		0.06	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	3/18/87		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	5/22/87		0.14	0.15				
	Sample Pt 7	Westport Mining Company Study	1779132	7/1/87		0.77	0.05	0.77			
	Sample Pt 7	Westport Mining Company Study	1779132	8/19/87		0.08	0.11				
	Sample Pt 7	Westport Mining Company Study	1779132	11/17/87		0.32	0.18				
	Sample Pt 7	Westport Mining Company Study	1779132	12/23/87		0.3	0.09	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	1/19/88		0.03	0.01				
	Sample Pt 7	Westport Mining Company Study	1779132	1/25/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	2/25/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	3/24/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	4/26/88		0.3	0.11	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	6/3/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	6/7/88		0.04	0.03				
	Sample Pt 7	Westport Mining Company Study	1779132	7/27/88		0.3	0.05	0.5			

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Sample Pt 7	Westport Mining Company Study	1779132	8/1/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	8/16/88		0.3	0.07	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	9/16/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	10/4/88		0.18	0.19				
	Sample Pt 7	Westport Mining Company Study	1779132	10/12/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	11/2/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	11/15/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	12/15/88		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	12/19/88		0.16	0.17				
	Sample Pt 7	Westport Mining Company Study	1779132	1/18/89		0.3	0.05	0.5			
	Sample Pt 7	Westport Mining Company Study	1779132	3/9/89		0.15	0.03	0.18			
	Sample Pt 7	Westport Mining Company Study	1779132	8/20/93		0.18	0.04	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	9/28/93		0.11	0.03	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	12/21/93		0.02	0.01	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	4/5/94		0.07	0.02	0.14			
	Sample Pt 7	Westport Mining Company Study	1779132	5/17/94		0.03	0.02	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	6/28/94		0.05	0.02	0.14			
	Sample Pt 7	Westport Mining Company Study	1779132	8/3/94		1.18	0.35	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	9/15/94		0.09	0.02	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	10/19/94		0.03	0.01	0.05			
	Sample Pt 7	Westport Mining Company Study	1779132	5/24/95		0.12	0.02	0.13			
	Sample Pt 7	Westport Mining Company Study	1779132	7/9/96		0.06	0.017	0.135			
	Station 4	Pet. Declare Unsuitable		7/12/84	2735	0.1	0.1	0.7	0	14	
	Station 4	Pet. Declare Unsuitable		7/26/84	1380	0.1	0.1	0.2	0	14	
	Station 4	Pet. Declare Unsuitable		8/22/84	3938	0.1	0.1	0.1	4	16	
	Station 4	Pet. Declare Unsuitable		9/6/84	1501	0.1	0.1	0.2	0	10	
	Station 4	Pet. Declare Unsuitable		10/16/84	693	0.1	0.1	0.1	0	14	
	Station 4	Pet. Declare Unsuitable		3/20/85	3558	< 0.3	< 0.05	< 0.5	0	12	
	1LMR	Biological/Chemical Stream Survey		3/20/85	*	< 0.3	< 0.05	< 0.5	0	12	
	1LMR	Biological/Chemical Stream Survey		4/29/85	*	< 0.01	< 0.01	< 0.04	10	14	
	1LMR	Biological/Chemical Stream Survey		3/9/89	*	0.15	0.03	0.18	0	14	
	1LMR	Biological/Chemical Stream Survey		3/21/85	*	1.62	0.15	< 0.05	0	12	
	1LMR	Biological/Chemical Stream Survey		4/30/85	*	1.46	0.21	< 0.04	12	12	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	1LMR	Biological/Chemical Stream Survey		3/9/89	*	0.76	0.15	0.05	0	14	
				Average =	3871.04	0.19	0.08	0.30	2.82	13.83	
				StDev =	3945.73	0.27	0.07	0.22	5.94	1.87	
UNT1 (historical)	Sample Pt 4	Westport Mining Company Study	1779132	3/5/83	*	2.6	1.56	1.16	*	6	
	Sample Pt 4	Westport Mining Company Study	1779132	6/4/84	754	1.9	1.9	1.4	102	4	
	Sample Pt 4	Westport Mining Company Study	1779132	7/12/84	720	3.4	5.5	5	122	0	
	Sample Pt 4	Westport Mining Company Study	1779132	7/26/84	225	5.4	7.7	3.6	86	0	
	Sample Pt 4	Westport Mining Company Study	1779132	8/22/84	568	3.8	4.4	2.9	76	2	
	Sample Pt 4	Westport Mining Company Study	1779132	9/6/84	219	8.6	7.7	6.4	100	0	
	Sample Pt 4	Westport Mining Company Study	1779132	10/16/84	124	13.8	11.1	7	122	0	
	Sample Pt 4	Westport Mining Company Study	1779132	3/21/85	485	4.17	2.5	1.58	*	4	
	Sample Pt 4	Westport Mining Company Study	1779132	4/30/85	293	5	3.75	1.72	46	0	
	Sample Pt 4	Westport Mining Company Study	1779132	6/7/85	*	13.25	7.52	1.75	46	0	
	Sample Pt 4	Westport Mining Company Study	1779132	3/13/86	991	4.21	4.3	3.11	62	0	
	Sample Pt 5 New	Westport Mining Company Study	1779132	2/25/88		0.3	0.19	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	3/24/88		0.3	0.11	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	4/26/88		0.3	0.14	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	6/3/88		0.3	0.15	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	7/27/88		0.3	0.37	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	8/16/88		0.3	0.34	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	9/16/88			0.54	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	10/12/88		0.5	0.86	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	11/15/88		0.3	0.4	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	12/15/88		0.3	0.29	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	1/18/89		0.3	0.1	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	1/25/89		0.3	0.19	0.5			
	Station 11	Petition to Declare Unsuitable for Mining		6/4/84	754	1.09	1.9	1.4	102	4	
	Station 11	Petition to Declare Unsuitable for Mining		7/12/84	720	3.4	5.5	5	122	0	
	Station 11	Petition to Declare Unsuitable for Mining		7/26/84	225	5.4	7.7	3.6	86	0	
	Station 11	Petition to Declare Unsuitable for Mining		8/22/84	568	3.8	4.4	2.9	76	2	
	Station 11	Petition to Declare Unsuitable for Mining		9/6/84	219	8.6	7.7	6.4	122	0	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Station 11	Petition to Declare Unsuitable for Mining		10/16/84	124	13.8	11.1	7	*	0	
	Station 11	Petition to Declare Unsuitable for Mining		3/21/85	485	4.17	2.5	1.58	*	4	
	Station 11	Petition to Declare Unsuitable for Mining		4/30/85	293	5	3.75	1.72	46	0	
	Station 11	Petition to Declare Unsuitable for Mining		6/7/85	*	13.25	7.52	1.75	46	0	
	2CR	Biological/Chemical Stream Survey		3/21/85	*	4.17	2.5	1.58	0	4	
	2CR	Biological/Chemical Stream Survey		4/30/85	*	5	3.75	1.72	46	0	
	2CR	Biological/Chemical Stream Survey		3/9/89	*	4.87	1.33	0.31	14	8	
				Average =	456.88	4.18	3.46	2.19	74.84	1.65	
				StDev =	264.89	4.18	3.29	2.07	37.18	2.39	
UNT1 (pipeline)	Sample Pt 5 New	Westport Mining Company Study	1779132	9/28/93		6.01	6.58	0.81			
	Sample Pt 5 New	Westport Mining Company Study	1779132	12/1/93		5.61	2.18	0.96			
	Sample Pt 5 New	Westport Mining Company Study	1779132	4/5/94		0.88	2.25	0.74			
	Sample Pt 5 New	Westport Mining Company Study	1779132	5/17/94		2.31	2.29	0.41			
	Sample Pt 5 New	Westport Mining Company Study	1779132	6/28/94		18.2	11.1	0.5			
	Sample Pt 5 New	Westport Mining Company Study	1779132	8/3/94		12.5	7.3	0.41			
	Sample Pt 5 New	Westport Mining Company Study	1779132	9/15/94		9.6	5.3	0.4			
	Sample Pt 5 New	Westport Mining Company Study	1779132	10/19/94		7.39	4.92	0.2			
	Sample Pt 5 New	Westport Mining Company Study	1779132	5/24/95		2.76	1.09	0.4			
	Sample Pt 5 New	Westport Mining Company Study	1779132	7/9/96		18	9.81	0.488			
				Average =		8.33	5.28	0.53			
				StDev =		6.20	3.43	0.23			
LMR2 (historical)	Sample Pt 3	Westport Mining Company Study	1779132	2/10/71	*	0.16	*	*	2	32	
	Sample Pt 3	Westport Mining Company Study	1779132	8/15/79	*	0.5	0.35	0.1	2	12	
	Sample Pt 3	Westport Mining Company Study	1779132	10/1/80	*	2.58	0.95	*	9	7	
	Sample Pt 3	Westport Mining Company Study	1779132	11/11/80	*	3.85	1.39	*	9	9	
	Sample Pt 3	Westport Mining Company Study	1779132	2/17/81	*	1.1	0.57	*	13	14	
	Sample Pt 3	Westport Mining Company Study	1779132	12/18/81	*	0.06	0.18	*	7	3	
	Sample Pt 3	Westport Mining Company Study	1779132	3/31/82	*	0.33	0.42	*	5	6	
	Sample Pt 3	Westport Mining Company Study	1779132	4/19/82	*	0.7	0.29	0.19	12	9	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Sample Pt 3	Westport Mining Company Study	1779132	5/25/82	*	0.87	0.56	*	12	6	
	Sample Pt 3	Westport Mining Company Study	1779132	9/9/82	*	2.92	1.09	*	0	6	
	Sample Pt 3	Westport Mining Company Study	1779132	11/20/82	*	0.02	0.95	*	2	10	
	Sample Pt 3	Westport Mining Company Study	1779132	1/31/83	*	4.45	1.24	0.6	18	9	
	Sample Pt 3	Westport Mining Company Study	1779132	2/25/83	*	0.16	0.08	*	2	5	
	Sample Pt 3	Westport Mining Company Study	1779132	3/2/83	*	1.39	0.38	0.11	16	10	
	Sample Pt 3	Westport Mining Company Study	1779132	4/19/83	*	0.02	0.07	*	5	4	
	Sample Pt 3	Westport Mining Company Study	1779132	8/15/83	*	2.38	1.2	*	13	7	
	Sample Pt 3	Westport Mining Company Study	1779132	10/5/83	*	7.46	2.11	0.29	34	8	
	Sample Pt 3	Westport Mining Company Study	1779132	12/10/83	*	0.03	0.03	0.32	5	11	
	Sample Pt 3	Westport Mining Company Study	1779132	2/6/84	*	0.03	0.1	*	0	7	
	Sample Pt 3	Westport Mining Company Study	1779132	5/25/84	*	0.01	0.41	*	22	10	
	Sample Pt 3	Westport Mining Company Study	1779132	6/4/84	6200	2.3	0.2	0.15	*	9	
	Sample Pt 3	Westport Mining Company Study	1779132	7/12/84	3945	1.7	1	1.6	*	7	
	Sample Pt 3	Westport Mining Company Study	1779132	7/26/84	1790	3	1.2	0.6	*	8	
	Sample Pt 3	Westport Mining Company Study	1779132	8/22/84	4543	1.5	0.8	0.4	42	10	
	Sample Pt 3	Westport Mining Company Study	1779132	9/6/84	1800	4	1.4	0.8	*	30	
	Sample Pt 3	Westport Mining Company Study	1779132	10/18/84	*	4.18	3.17	*	32	2	
	Sample Pt 3	Westport Mining Company Study	1779132	10/16/84	777	7.5	2.5	1.2	48	9	
	Sample Pt 3	Westport Mining Company Study	1779132	1/7/85	*	0.83	0.53	*	20	4	
	Sample Pt 3	Westport Mining Company Study	1779132	3/21/85	3931	2.69	0.53	0.5	19	9	
	Sample Pt 3	Westport Mining Company Study	1779132	4/30/85	2907	2.61	0.9	0.39	18	0	
	Sample Pt 3	Westport Mining Company Study	1779132	5/15/85	*	1.45	0.59	*	20	50	
	Sample Pt 3	Westport Mining Company Study	1779132	6/7/85	*	5.29	1.25	0.21	14	8	
	Sample Pt 3	Westport Mining Company Study	1779132	7/8/85	*	6.35	3.84	1.92	30	8	
	Sample Pt 3	Westport Mining Company Study	1779132	7/29/85	*	2.9	1.31	*	2	8	
	Sample Pt 3	Westport Mining Company Study	1779132	9/26/85	*	16.82	3.37	0.5	66	8	
	Sample Pt 3	Westport Mining Company Study	1779132	10/14/85	*	9.1	3.8	*	56	2	
	Sample Pt 3	Westport Mining Company Study	1779132	12/27/85	*	3.53	0.9	0.5	48	9	
	Sample Pt 3	Westport Mining Company Study	1779132	2/13/86	8349	2.49	1.2	1.02	30	6	
	Station 12	Petition to Declare Unsuitable for Mining		6/4/84	6200	2.3	0.2	0.15	*	9	
	Station 12	Petition to Declare Unsuitable for Mining		7/12/84	3945	1.7	1	1.6	*	7	
	Station 12	Petition to Declare Unsuitable for Mining		7/26/84	1790	3	1.2	0.6	*	8	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Station 12	Petition to Declare Unsuitable for Mining		8/22/84	1800	4	1.4	0.8	*	30	
	Station 12	Petition to Declare Unsuitable for Mining		3/21/85	3931	2.69	0.53	< 0.5	*	8	
	Station 12	Petition to Declare Unsuitable for Mining		4/30/85	2907	2.61	0.9	0.39	18	*	
	Station 12	Petition to Declare Unsuitable for Mining		6/7/85	*	5.29	1.25	0.21	14	8	
	3LMR	Biological/Chemical Stream Survey		3/21/85	*	2.69	0.53	< 0.05	0	8	
	3LMR	Biological/Chemical Stream Survey		4/30/85	*	2.61	0.9	0.39	18	0	
	3LMR	Biological/Chemical Stream Survey		3/9/89	*	1.66	0.35	0.1	2	11	
				Average =	3654.33	2.83	1.05	0.58	17.56	9.81	
				StDev =	2058.73	2.96	0.93	0.49	16.49	8.77	
LMR2 (pipeline)	S3	Bob Deardorff BAMR data		8/20/93		0.49	0.46	0.13	17	10	6.4
	S3	Bob Deardorff BAMR data		9/30/93		1.2	1.59	0.64	8	9	6.4
	S3	Bob Deardorff BAMR data		12/22/93		0.11	0.14	0.13	7	7	6.3
	S3	Bob Deardorff BAMR data		4/5/93		0.23	0.12	0.2	3	4	6.4
	S3	Bob Deardorff BAMR data		5/17/94		0.13	0.19	0.22	0	6	6.4
	S3	Bob Deardorff BAMR data		6/28/94		0.47	0.08	0.14	0	10	6.9
	S3	Bob Deardorff BAMR data		8/3/94		0.28	0.24	0.13	0	11	6.4
	S3	Bob Deardorff BAMR data		9/15/94		0.33	0.08	0.15	0	11	6.2
	S3	Bob Deardorff BAMR data		10/19/94		0.16	0.13	0.13	11	12	6.3
	S3	Bob Deardorff BAMR data		5/24/95		0.2	0.09	0.22	0	7	6.5
	S3	Bob Deardorff BAMR data		7/9/96		0.097	0.023	0.741	0	11	6.5
				Average =		0.34	0.29	0.26	4.18	8.91	6.43
				StDev =		0.32	0.45	0.22	5.83	2.55	0.18
LMR3 (historical)	Sample Pt 2	Westport Mining Company Study	1779132	7/2/70	1036.728	0.1	*	*	*	10	
	Sample Pt 2	Westport Mining Company Study	1779132	7/30/70	3796.848	3	*	*	*	6	
	Sample Pt 2	Westport Mining Company Study	1779132	8/31/70	2997.984	0.5	*	*	*	5	
	Sample Pt 2	Westport Mining Company Study	1779132	9/30/70	973.896	0.1	*	*	*	8	
	Sample Pt 2	Westport Mining Company Study	1779132	29-Oct	2419.032	0.4	*	*	*	10	
	Sample Pt 2	Westport Mining Company Study	1779132	11/29/70	5255.448	0.2	*	*	*	10	
	Sample Pt 2	Westport Mining Company Study	1779132	28-Dec	8046.984	0	*	*	*	10	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Sample Pt 2	Westport Mining Company Study	1779132	1/23/71	14161.88	0.4	*	*	*	8	
	Sample Pt 2	Westport Mining Company Study	1779132	2/4/71		0.13					
	Sample Pt 2	Westport Mining Company Study	1779132	3/5/71	20200.94	0.2	*	*	*	4	
	Sample Pt 2	Westport Mining Company Study	1779132	3/23/71		0.25					
	Sample Pt 2	Westport Mining Company Study	1779132	4/8/71	5618.976	0.1	*	*	*	8	
	Sample Pt 2	Westport Mining Company Study	1779132	5/11/71	4954.752	0.4	*	*	*	6	
	Sample Pt 2	Westport Mining Company Study	1779132	6/22/71	1494.504	0.2	*	*	*	8	
	Sample Pt 2	Westport Mining Company Study	1779132	12/15/71		0.1					
	Sample Pt 2	Westport Mining Company Study	1779132	1/4/78	*	0.18	*	*	0	7	
	Sample Pt 2	Westport Mining Company Study	1779132	9/1/79	1000	0.11	0.72	*	7	0	
	Sample Pt 2	Westport Mining Company Study	1779132	12/28/79	*	0.11	0.72	*	4	0	
	Sample Pt 2	Westport Mining Company Study	1779132	3/11/80	*	0.33	0.33	*	10	0	
	Sample Pt 2	Westport Mining Company Study	1779132	6/30/80	*	0.21	0.98	*	6	0	
	Sample Pt 2	Westport Mining Company Study	1779132	9/11/80	*	0.84	0.51	*	9	4	
	Sample Pt 2	Westport Mining Company Study	1779132	12/9/80	*	0.39	0.46	*	10	6	
	Sample Pt 2	Westport Mining Company Study	1779132	Apr-81	*	0.67	4.92	*	4	7	
	Sample Pt 2	Westport Mining Company Study	1779132	Jul-81	*	0.24	0.27	*	0	39	
	Sample Pt 2	Westport Mining Company Study	1779132	9/7/81	*	0.2	0.93	*	14	3	
	Sample Pt 2	Westport Mining Company Study	1779132	12/1/81	*	1.11	0.56	*	6	6	
	Sample Pt 2	Westport Mining Company Study	1779132	3/31/82	*	0.3	0.37	*	2	8	
	Sample Pt 2	Westport Mining Company Study	1779132	6/3/82	*	0.37	0.32	*	9	11	
	Sample Pt 2	Westport Mining Company Study	1779132	8/31/82	*	0.34	1.06	*	4	4	
	Sample Pt 2	Westport Mining Company Study	1779132	11/20/82	*	0.14	0.34	*	2	11	
	Sample Pt 2	Westport Mining Company Study	1779132	2/24/83	*	0.28	0.37	*	0	0	
	Sample Pt 2	Westport Mining Company Study	1779132	3/2/83	*	0.91	0.38	0.06	22	9	
	Sample Pt 2	Westport Mining Company Study	1779132	4/23/83	*	0.04	0.11	*	3	5	
	Sample Pt 2	Westport Mining Company Study	1779132	8/15/83	*	0.17	0.69	*	4	6	
	Sample Pt 2	Westport Mining Company Study	1779132	12/6/83		0.54	0.68	0.28			
	Sample Pt 2	Westport Mining Company Study	1779132	12/13/83	*	0.01	0.19	*	3	10	
	Sample Pt 2	Westport Mining Company Study	1779132	6/5/84	5563	0.1	0.3	0.2	*	9	
	Sample Pt 2	Westport Mining Company Study	1779132	6/7/84		2.99	1.43	0.03			
	Sample Pt 2	Westport Mining Company Study	1779132	7/12/84	4260	1.6	1.1	2.1	*	7	
	Sample Pt 2	Westport Mining Company Study	1779132	7/26/84	1430	2.4	1.2	0.6	*	7	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Sample Pt 2	Westport Mining Company Study	1779132	8/22/84	4540	1.2	0.9	0.3	*	11	
	Sample Pt 2	Westport Mining Company Study	1779132	9/6/84	1900	4.5	1.9	0.5	*	8	
	Sample Pt 2	Westport Mining Company Study	1779132	10/16/84	777	2.1	2.3	1	46	3	
	Sample Pt 2	Westport Mining Company Study	1779132	10/30/84		0.62	4.12				
	Sample Pt 2	Westport Mining Company Study	1779132	11/19/84		2.82	2.31				
	Sample Pt 2	Westport Mining Company Study	1779132	12/4/84		1.5	0.78				
	Sample Pt 2	Westport Mining Company Study	1779132	1/24/85		3.54	1.05				
	Sample Pt 2	Westport Mining Company Study	1779132	4/16/85		1.21	0.54				
	Sample Pt 2	Westport Mining Company Study	1779132	6/5/85		1.83	1				
	Sample Pt 2	Westport Mining Company Study	1779132	6/7/85	*	1.43	1.43	0.03	14	7	
	Sample Pt 2	Westport Mining Company Study	1779132	3/9/89		2.13	0.51	0.08			
	Station 14	Petition to Declare Unsuitable for Mining		6/5/84	5563	0.1	0.3	0.2	*	9	
	Station 14	Petition to Declare Unsuitable for Mining		7/12/84	4260	1.6	1.1	2.1	*	7	
	Station 14	Petition to Declare Unsuitable for Mining		7/26/84	1430	2.4	1.2	0.6	*	7	
	Station 14	Petition to Declare Unsuitable for Mining		8/22/84	4540	1.2	0.9	0.3	*	11	
	Station 14	Petition to Declare Unsuitable for Mining		9/6/85	1900	4.5	1.9	0.5	*	8	
	Station 14	Petition to Declare Unsuitable for Mining		10/16/85	700	2.1	2.3	1	0	3	
	Station 14	Petition to Declare Unsuitable for Mining		6/7/85	*	2.99	1.43	< 0.035	14	7	
	5LMR	Biological/Chemical Stream Survey		3/14/86	*	1.55	0.62	0.44	28	8	
	5LMR	Biological/Chemical Stream Survey		3/9/89	*	2.13	0.51	0.08	4	10	
				Average =	4352.84	1.04	1.05	0.55	8.65	7.31	
				StDev =	4424.28	1.15	0.96	0.62	10.23	5.63	
LMR3 (pipeline)	Sample Pt 2	Bob Deardorf BAMR Data		8/20/93		0.76	0.76	0.21			6.1
	Sample Pt 2			9/28/93		1.66	1.43	0.67			5.7
	Sample Pt 2			12/21/93		0.23	0.17	0.17			6.2
	Sample Pt 2			4/5/94		0.81	0.13	0.26			6.3
	Sample Pt 2			5/17/94		0.21	0.18	0.14			6.4
	Sample Pt 2			6/28/94		0.21	0.04	0.14			5.9
	Sample Pt 2			8/3/94		2.4	0.16	0.13			6.3
	Sample Pt 2			9/15/94		0.53	0.06	0.42			6
	Sample Pt 2			10/19/94		0.27	0.03	0.13			6.3

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	Sample Pt 2			5/24/95		0.32	0.1	0.19			6.5
				Average =		0.74	0.31	0.25			6.2
				StDev =		0.74	0.45	0.17			0.2
LMR4 (historical)	CAR 10A	Cambria Coal Co.	1.8E+07	Sep-75	*	5.55	*	*	0	26	
	CAR 10A	Cambria Coal Co.	1.8E+07	3/3/82	5000	0.32	0.52	*	2	9	
	CAR 10A	Cambria Coal Co.	1.8E+07	8/10/82	750	0.25	0.15	*	6	10	
	CAR 10A	Cambria Coal Co.	1.8E+07	10/23/82	300	0.02	0.16	*	8	6	
	CAR 10A	Cambria Coal Co.	1.8E+07	2/19/83	950	0.21	0.44	*	11	2	
	CAR 10A	Cambria Coal Co.	1.8E+07	6/2/83	1000	0.3	0.28	*	0	10	
	CAR 10A	Cambria Coal Co.	1.8E+07	8/29/83	100	0.71	0.5	*	3	12	
	CAR 10A	Cambria Coal Co.	1.8E+07	11/17/83	400	0.18	2.37	*	6	5	
	CAR 10A	Cambria Coal Co.	1.8E+07	2/16/84	800	0.41	0.35	*	4	7	
	CAR 10A	Cambria Coal Co.	1.8E+07	6/5/84	550	0.29	0.39	*	14	6	
	CAR 10A	Cambria Coal Co.	1.8E+07	8/21/84	1000	0.25	0.44	*	6	6	
	CAR 10A	Cambria Coal Co.	1.8E+07	10/30/84	250	0.12	2.43	*	2	14	
	CAR 10A	Cambria Coal Co.	1.8E+07	3/14/85	1500	0.46	0.68	*	5	3	
	CAR 10A	Cambria Coal Co.	1.8E+07	6/10/85	0	0.47	0.87	*	2	4	
	CAR 10A	Cambria Coal Co.	1.8E+07	8/12/85	350	0.98	2.08	*	2	4	
	CAR 10A	Cambria Coal Co.	1.8E+07	4/30/87	900	0.8	0.7	*	1	4	
	CAR 10A	Cambria Coal Co.	1.8E+07	9/9/87	750	0.46	2.69	*	0	19	
	CAR 10A	Cambria Coal Co.	1.8E+07	10/12/87	900	0.43	2.99	*	5	13	
	CAR 10A	Cambria Coal Co.	1.8E+07	2/8/88	1000	1.46	0.65	*	4	4	
	CAR 10A	Cambria Coal Co.	1.8E+07	4/15/88	800	0.79	0.58	*	5	6	
	CAR 10A	Cambria Coal Co.	1.8E+07	7/29/88	250	0.4	1.61	*	5	10	
	CAR 10A	Cambria Coal Co.	1.8E+07	10/31/88	300	0.27	1.48	*	5	17	
	CAR 10A	Cambria Coal Co.	1.8E+07	1/19/89	150	0.58	0.46	*	5	13	
	CAR 10A	Cambria Coal Co.	1.8E+07	5/17/89	3000	0.73	0.34	*	2	8	
	CAR 10A	Cambria Coal Co.	1.8E+07	8/17/89	800	0.35	4.35	*	15	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	10/26/89	900	0.36	2.09	*	7	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	2/12/90	1000	1.41	1.02	*	4	1	
	CAR 10A	Cambria Coal Co.	1.8E+07	6/5/90	400	0.05	0.04	*	0	29	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	CAR 10A	Cambria Coal Co.	1.8E+07	8/9/90	800	2.21	4.2	*	20	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	11/29/90	1000	5.78	3.18	*	18	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	2/28/91	180	4.91	2.17	*	15	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	6/10/91	1000	1.78	5.03	*	31	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	7/15/91	950	1.13	11.42	*	47	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	12/5/91	1000	4.33	3.09	*	19	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	2/6/92	900	4.98	1.86	*	11	4	
	CAR 10A	Cambria Coal Co.	1.8E+07	4/13/92	1000	2.8	1.37	*	11	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	8/4/92	1000	6.12	5.28	*	34	0	
	CAR 10A	Cambria Coal Co.	1.8E+07	12/2/92	1000	3.38	1.98	*	21	1	
	CAR 1	Cambria Coal Co.	1.8E+07	4/1/79	350	0.39	0.21	0	2	3	
	CAR 1	Cambria Coal Co.	1.8E+07	2/17/81	2000	0.94	0.63	*	35	7	
	CAR 1	Cambria Coal Co.	1.8E+07	6/12/81	1600	0.62	0.38	*	13	6	
	CAR 1	Cambria Coal Co.	1.8E+07	8/6/81	850	0.41	0.25	*	4	6	
	CAR 1	Cambria Coal Co.	1.8E+07	11/1/81	750	0.57	0.87	*	9	4	
	CAR 1	Cambria Coal Co.	1.8E+07	2/15/82	650	0.89	0.52	*	5	4	
	CAR 1	Cambria Coal Co.	1.8E+07	5/27/82	300	0.35	0.47	*	4	40	
	CAR 1	Cambria Coal Co.	1.8E+07	8/4/82	650	0.19	0.29	*	4	4	
	CAR 1	Cambria Coal Co.	1.8E+07	10/23/82	250	0.08	1.41	*	8	4	
	CAR 1	Cambria Coal Co.	1.8E+07	2/19/83	750	0.68	0.55	*	7	4	
	CAR 1	Cambria Coal Co.	1.8E+07	6/1/83	950	0.4	0.34	*	0	15	
	CAR 1	Cambria Coal Co.	1.8E+07	7/25/83	250	0.42	0.42	*	4	3	
	CAR 1	Cambria Coal Co.	1.8E+07	11/8/83	500	0.07	0.02	*	2	142	
	CAR 1	Cambria Coal Co.	1.8E+07	2/2/84	900	1.77	1.18	*	8	2	
	CAR 1	Cambria Coal Co.	1.8E+07	6/18/84	1000	0.83	0.71	*	17	4	
	CAR 1	Cambria Coal Co.	1.8E+07	8/21/84	1000	0.4	0.52	*	7	5	
	CAR 1	Cambria Coal Co.	1.8E+07	11/13/84	900	0.39	2.93	*	13	1	
	CAR 1	Cambria Coal Co.	1.8E+07	3/12/85	2000	1.05	0.78	*	6	2	
	CAR 1	Cambria Coal Co.	1.8E+07	6/6/85	900	0.55	1.08	*	27	3	
	CAR 1	Cambria Coal Co.	1.8E+07	8/12/85	350	0.05	1.94	*	2	4	
	CAR 1	Cambria Coal Co.	1.8E+07	10/17/85	175	0.05	4.02	*	17	2	
	CAR 1	Cambria Coal Co.	1.8E+07	1/30/86	900	1.4	0.61	*	7	3	
	CAR 1	Cambria Coal Co.	1.8E+07	5/6/86	750	1.04	0.65	*	5	2	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	CAR 1	Cambria Coal Co.	1.8E+07	8/28/86	2000	0.16	2.05	*	8	2	
	CAR 1	Cambria Coal Co.	1.8E+07	12/22/86	800	2.47	0.75	*	6	2	
	CAR 1	Cambria Coal Co.	1.8E+07	2/24/87	700	4.9	1.68	*	26	1	
	CAR 1	Cambria Coal Co.	1.8E+07	5/21/87	900	1.86	0.12	*	8	0	
	CAR 1	Cambria Coal Co.	1.8E+07	8/31/87	950	0.51	3.25	*	12	0	
	CAR 1	Cambria Coal Co.	1.8E+07	11/4/87	750	0.81	2.85	*	17	0	
	CAR 1	Cambria Coal Co.	1.8E+07	2/8/88	600	1.86	1.69	*	10	1	
	CAR 1	Cambria Coal Co.	1.8E+07	5/17/88	900	1.21	0.68	*	3	3	
	CAR 1	Cambria Coal Co.	1.8E+07	8/12/88	150	0.11	1.79	*	0	7	
	CAR 1	Cambria Coal Co.	1.8E+07	11/16/88	600	0.43	1.73	*	8	0	
	CAR 1	Cambria Coal Co.	1.8E+07	2/8/89	600	2.47	0.57	*	4	2	
	CAR 1	Cambria Coal Co.	1.8E+07	6/1/89	1000	2.03	1.14	*	2	1	
	CAR 1	Cambria Coal Co.	1.8E+07	9/7/89	650	0.92	7.22	*	34	0	
	CAR 1	Cambria Coal Co.	1.8E+07	10/26/89	800	0.98	2.05	*	8	0	
	CAR 1	Cambria Coal Co.	1.8E+07	3/7/90	800	6.45	2.89	*	19	0	
	CAR 1	Cambria Coal Co.	1.8E+07	6/4/90	1000	4.85	2.24	*	12	0	
	CAR 1	Cambria Coal Co.	1.8E+07	8/1/90	1000	4.46	2.95	*	15	0	
	CAR 1	Cambria Coal Co.	1.8E+07	11/29/90	1000	8.06	3.44	*	24	0	
	CAR 1	Cambria Coal Co.	1.8E+07	2/28/91	1000	5.27	2.25	*	14	0	
	CAR 1	Cambria Coal Co.	1.8E+07	6/10/91	1000	7	5.15	*	37	0	
	CAR 1	Cambria Coal Co.	1.8E+07	9/25/91	800	9.63	14.77	*	77	0	
	CAR 1	Cambria Coal Co.	1.8E+07	12/5/91	1000	5.77	3.25	*	24	0	
	CAR 1	Cambria Coal Co.	1.8E+07	2/6/92	800	7.97	2.86	*	26	0	
	CAR 1	Cambria Coal Co.	1.8E+07	4/13/92	1000	3.34	1.38	*	8	0	
	CAR 1	Cambria Coal Co.	1.8E+07	8/4/92	1000	6.14	5.35	*	30	0	
	CAR 1	Cambria Coal Co.	1.8E+07	12/9/92	1000	6.42	2.63	*	26	0	
	MR 19	C&K Coal Company	1.8E+07	1/1/89	3100	0.69	0.45	0	3	4	
	MR 19	C&K Coal Company	1.8E+07	Apr-89	5500	0.33	0.29	0.1	1	6	
	MR 19	C&K Coal Company	1.8E+07	May-89	6800	1.13	0.8	0.2	7	5	
	MR 19	C&K Coal Company	1.8E+07	Jun-89	6000	1.06	1.07	0.1	1	2	
	MR 19	C&K Coal Company	1.8E+07	Jul-89	4000	1.04	1.77	0.1	6	2	
	MR 19	C&K Coal Company	1.8E+07	Aug-89	3000	0.26	2.76	0.3	12	0	
	MR 19	C&K Coal Company	1.8E+07	12/8/89	4500	0.41	2.1	0.2	10	0	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	MR 19	C&K Coal Company	1.8E+07	2/19/90	5500	1.42	1.04	0.3	4	2	
	MR 19	C&K Coal Company	1.8E+07	6/5/90	3000	2.76	2.09	0.1	11	0	
	MR 19	C&K Coal Company	1.8E+07	8/8/90	800	2.2	4.18	0.5	19	0	
	MR 19	C&K Coal Company	1.8E+07	11/29/90	1000	5.8	3.17	0.1	22	0	
	MR 19	C&K Coal Company	1.8E+07	2/28/91	1000	4.98	2.12	0.1	11	0	
	MR 19	C&K Coal Company	1.8E+07	6/10/91	1000	1.79	4.96	0.8	30	0	
	MR 19	C&K Coal Company	1.8E+07	7/15/91	950	1.23	11.12	1.6	46	0	
	MR 19	C&K Coal Company	1.8E+07	12/5/91	1000	4.36	3.11	0.4	16	0	
	MR 19	C&K Coal Company	1.8E+07	2/6/92	900	5.14	1.91	0.5	12	3	
	MR 19	C&K Coal Company	1.8E+07	4/13/92	1000	2.84	1.32	0.1	13	0	
	MR 19	C&K Coal Company	1.8E+07	8/4/92	1000	6.14	5.21	0.5	25	0	
	MR 19	C&K Coal Company	1.8E+07	12/2/92	1000	3.37	1.97	0.1	19	1	
				Average =	1195.29	2.01	2.09	0.31	12.15	5.35	
				StDev =	1259.70	2.26	2.33	0.37	12.13	14.81	
LMR4 (pipeline)	CAR 10A	Cambria Coal Co.	1.8E+07	3/8/93	2000	6.94	2.92	*	6	10	7.5
	CAR 10A	Cambria Coal Co.	1.8E+07	4/7/93	1000	0.31	0.35	*	0	14	6.4
	CAR 10A	Cambria Coal Co.	1.8E+07	3/14/94	3000	0.11	0.25	*	0	14	6.1
	CAR 10A	Cambria Coal Co.	1.8E+07	6/25/94	200	0.35	0.12	*	0	28	6
	CAR 10A	Cambria Coal Co.	1.8E+07	9/19/94	*	0.67	0.06	*	0	22	6.9
	CAR 10A	Cambria Coal Co.	1.8E+07	12/1/94	*	0.19	0.2	*	0	14	4.8
	CAR 10A	Cambria Coal Co.	1.8E+07	2/13/95	*	0.04	0.02	*	0	16	7
	CAR 1	Cambria Coal Co.	1.8E+07	2/25/93	*	12.8	6.03	*	48	2	4.6
	CAR 1	Cambria Coal Co.	1.8E+07	4/7/93	1000	1.63	0.92	*	0	8	6.7
	CAR 1	Cambria Coal Co.	1.8E+07	3/14/94	2500	0.09	0.26	*	0	16	6.4
	CAR 1	Cambria Coal Co.	1.8E+07	6/25/94	*	0.44	0.16	*	0	24	4.8
	CAR 1	Cambria Coal Co.	1.8E+07	9/19/94	385	0.4	0.04	*	0	18	6.7
	CAR 1	Cambria Coal Co.	1.8E+07	11/7/94	*	0.612	0.05	0.5	0	20	*
	CAR 1	Cambria Coal Co.	1.8E+07	12/1/94	*	0.2	0.2	*	0	18	4.6
	CAR 1	Cambria Coal Co.	1.8E+07	2/13/95	*	0.05	0.01	*	0	16	7.1
	MR 19	C&K Coal Company	1.8E+07	3/8/93	2000	6.87	2.85	1	0	24	7.5
	MR 19	C&K Coal Company	1.8E+07	4/7/93	1000	0.36	0.34	0.2	0	16	6.4

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	MR 19	C&K Coal Company	1.8E+07	7/23/93	650	0.01	4.14	0	24	4	5.9
	MR 19	C&K Coal Company	1.8E+07	6/30/94	200	0.35	0.12	0.1	0	28	6
	MR 19	C&K Coal Company	1.8E+07	12/14/94	*	0.3	0.104	0.5	0	16.6	*
	MR 19	C&K Coal Company	1.8E+07	5/23/95	*	0.41	0.091	< 0.5	0.2	14.8	*
	MR 19	C&K Coal Company	1.8E+07	3/12/96	*	< 0.3	0.105	< 0.5	9	12.2	*
	MR 19	C&K Coal Company	1.8E+07	7/25/96	*	< 0.3	0.074	< 0.5	0	16.8	*
	MR 19	C&K Coal Company	1.8E+07	2/27/97	*	< 0.3	0.058	< 0.5	1	15	*
				Average =	1266.82	1.58	0.81	0.38	3.68	16.14	6.19
				StDev =	961.65	3.25	1.56	0.37	10.78	6.41	0.94
EB1	MR 16	C&K Coal Company	1.8E+07	1/1/89	325	0.15	0.21	0	0	19	7.1
	MR 16	C&K Coal Company	1.8E+07	Apr-89	350	0.14	0.2	0.4	0	18	6.5
	MR 16	C&K Coal Company	1.8E+07	May-89	400	0.1	0.15	0.5	0	14	6.6
	MR 16	C&K Coal Company	1.8E+07	Jun-89	300	0.15	0.16	0.1	0	23	6.9
	MR 16	C&K Coal Company	1.8E+07	Jul-89	350	1.11	0.41	0.2	0	41	6.6
	MR 16	C&K Coal Company	1.8E+07	Aug-89	75	0.12	0.03	0.1	0	67	6.5
	MR 16	C&K Coal Company	1.8E+07	12/8/89	100	0.07	0.21	0.1	0	34	6.9
	MR 16	C&K Coal Company	1.8E+07	2/19/90	250	0.05	0.18	0.2	0	12	7.9
	MR 16	C&K Coal Company	1.8E+07	6/5/90	300	0.05	0.08	0.1	0	32	7.3
	MR 16	C&K Coal Company	1.8E+07	8/8/90	250	0.07	0.12	0.1	0	40	7.5
	MR 16	C&K Coal Company	1.8E+07	11/29/90	475	0.09	0.19	0.1	0	30	7.2
	MR 16	C&K Coal Company	1.8E+07	2/28/91	650	0.2	0.24	0.2	0	25	7
	MR 16	C&K Coal Company	1.8E+07	6/10/91	28	0.06	0.03	0.1	0	59	7.6
	MR 16	C&K Coal Company	1.8E+07	7/15/91	267	0.22	0.08	0.2	0	38	6.1
	MR 16	C&K Coal Company	1.8E+07	12/5/91	850	0.16	0.37	0.6	1	6	6
	MR 16	C&K Coal Company	1.8E+07	2/6/92	250	0.08	0.19	0.4	0	23	6.1
	MR 16	C&K Coal Company	1.8E+07	4/13/92	210	0.07	0.14	0.2	0	23	6.8
	MR 16	C&K Coal Company	1.8E+07	8/4/92	210	0.26	0.17	0.4	0	31	6.6
	MR 16	C&K Coal Company	1.8E+07	12/2/92	210	0.39	0.22	0.5	0	22	7
	MR 16	C&K Coal Company	1.8E+07	3/8/93	350	0.43	0.26	1	0	22	7.8
	MR 16	C&K Coal Company	1.8E+07	4/7/93	400	0.13	0.29	0.4	0	18	6.3
	MR 16	C&K Coal Company	1.8E+07	6/30/94	5	0.04	0.16	0.1	0	24	6

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	MR 16	C&K Coal Company	1.8E+07	12/19/94	*	0.453	0.233	0.5	0	24	*
	MR 16	C&K Coal Company	1.8E+07	5/22/95	*	0.422	0.152	< 0.5	0	22	*
	MR 16	C&K Coal Company	1.8E+07	7/31/95	*	< 0.3	0.075	< 0.5	0	46	*
	MR 16	C&K Coal Company	1.8E+07	3/12/96	*	< 0.3	0.174	< 0.5	3.6	22	*
	MR 16	C&K Coal Company	1.8E+07	7/24/96	*	0.33	0.19	< 0.5	0	24	*
	MR 16	C&K Coal Company	1.8E+07	2/26/97	*	< 0.3	0.138	< 0.5	0	24	*
	MR 16	C&K Coal Company	1.8E+07	7/17/97	*	0.595	0.096	0.287	0	50	*
	MR 18	C&K Coal Company	1.8E+07	1/1/89	430	0.05	0.08	0	0	18	7.5
	MR 18	C&K Coal Company	1.8E+07	Apr-89	650	0.08	0.12	0.2	0	34	6.7
	MR 18	C&K Coal Company	1.8E+07	May-89	700	0.07	0.1	0.5	0	15	6.5
	MR 18	C&K Coal Company	1.8E+07	Jun-89	575	0.07	0.07	0.1	0	23	7.3
	MR 18	C&K Coal Company	1.8E+07	Jul-89	475	0.69	0.14	0.2	0	38	7.1
	MR 18	C&K Coal Company	1.8E+07	Aug-89	200	0.05	0.03	0.1	0	48	6
	MR 18	C&K Coal Company	1.8E+07	12/8/89	225	0.05	0.03	0.1	0	30	7.9
	MR 18	C&K Coal Company	1.8E+07	2/19/90	450	0.05	0.13	0.1	0	12	8.3
	MR 18	C&K Coal Company	1.8E+07	6/5/90	400	0.05	0.04	0.1	0	29	7.5
	MR 18	C&K Coal Company	1.8E+07	8/8/90	250	0.09	0.05	0.1	0	37	7.5
	MR 18	C&K Coal Company	1.8E+07	11/29/90	500	0.05	0.04	0.1	0	27	7.3
	MR 18	C&K Coal Company	1.8E+07	2/28/91	700	0.11	0.13	0.1	0	25	7.1
	MR 18	C&K Coal Company	1.8E+07	6/10/91	35	0.07	0.03	0.1	0	48	7.3
	MR 18	C&K Coal Company	1.8E+07	7/15/91	200	0.05	0.03	0.1	0	49	6.9
	MR 18	C&K Coal Company	1.8E+07	12/5/91	900	0.05	0.24	0.3	1	7	6.5
	MR 18	C&K Coal Company	1.8E+07	2/6/92	300	0.05	0.08	0.3	0	25	6.9
	MR 18	C&K Coal Company	1.8E+07	4/13/92	350	0.05	0.05	0.1	0	20	7.1
	MR 18	C&K Coal Company	1.8E+07	8/4/92	275	0.24	0.16	0.4	0	30	6.7
	MR 18	C&K Coal Company	1.8E+07	12/2/92	250	0.09	0.1	0.1	0	21	6.8
	MR 18	C&K Coal Company	1.8E+07	3/8/93	*	0.45	0.25	1	2	10	7.8
	MR 18	C&K Coal Company	1.8E+07	4/7/93	450	0.09	0.23	0.1	0	18	6.4
	MR 18	C&K Coal Company	1.8E+07	7/23/93	3	0.01	0.04	0	0	54	6.3
	MR 18	C&K Coal Company	1.8E+07	6/30/94	32	0.01	0.1	0.1	0	66	6.2
	MR 18	C&K Coal Company	1.8E+07	12/14/94	*	0.3	0.145	0.5	0	24	*
	MR 18	C&K Coal Company	1.8E+07	5/23/95	*	< 0.3	0.061	< 0.5	0	22	*
	MR 18	C&K Coal Company	1.8E+07	3/12/96	*	< 0.3	0.123	< 0.5	4.8	22	*

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	MR 18	C&K Coal Company	1.8E+07	7/25/96	*	< 0.3	< 0.05	< 0.5	0	24	*
	MR 18	C&K Coal Company	1.8E+07	2/26/97	*	<0.3	0.082	< 0.5	0	24	*
				Average =	339.89	0.18	0.14	0.24	0.22	28.65	6.93
				StDev =	214.74	0.21	0.09	0.22	0.84	13.70	0.58
UNT2	MR 17	C&K Coal Company	1.8E+07	1/1/89	38	0.05	0.03	0	0	66	7.3
	MR 17	C&K Coal Company	1.8E+07	Apr-89	600	0.05	0.03	0.1	0	17	6.9
	MR 17	C&K Coal Company	1.8E+07	May-89	722	0.07	0.03	0	0	21	6.8
	MR 17	C&K Coal Company	1.8E+07	Jun-89	600	0.06	0.04	0.1	0	28	6.9
	MR 17	C&K Coal Company	1.8E+07	Jul-89	300	0.11	0.03	0.1	0	45	7.2
	MR 17	C&K Coal Company	1.8E+07	Aug-89	100	0.05	0.03	0.1	0	79	6.9
	MR 17	C&K Coal Company	1.8E+07	12/8/89	100	0.05	0.03	0.1	0	60	7.8
	MR 17	C&K Coal Company	1.8E+07	2/19/90	250	0.05	0.03	0.1	0	29	8.2
	MR 17	C&K Coal Company	1.8E+07	6/5/90	35	0.05	0.03	0.1	0	61	7.5
	MR 17	C&K Coal Company	1.8E+07	8/8/90	100	0.12	0.12	0.1	0	75	7.1
	MR 17	C&K Coal Company	1.8E+07	11/29/90	350	0.2	0.07	0.1	0	56	7.2
	MR 17	C&K Coal Company	1.8E+07	2/28/91	275	0.28	0.16	0.1	0	55	7.1
	MR 17	C&K Coal Company	1.8E+07	6/10/91	40	0.09	0.07	0.1	0	159	6.4
	MR 17	C&K Coal Company	1.8E+07	7/15/91	40	0.12	0.1	0.1	0	149	6.9
	MR 17	C&K Coal Company	1.8E+07	12/5/91	225	0.09	0.08	0.1	0	75	6.8
	MR 17	C&K Coal Company	1.8E+07	2/6/92	30	0.07	0.04	0.1	0	116	6.5
	MR 17	C&K Coal Company	1.8E+07	4/13/92	90	0.99	0.84	1	0	94	7.1
	MR 17	C&K Coal Company	1.8E+07	8/4/92	2	0.55	3.63	0.2	0	34	7.2
	MR 17	C&K Coal Company	1.8E+07	12/2/92	65	0.33	0.03	0.1	0	70	5.8
	MR 17	C&K Coal Company	1.8E+07	3/8/93	220	1.01	0.87	1	0	16	8
	MR 17	C&K Coal Company	1.8E+07	4/7/93	450	0.15	0.07	0	0	46	6.3
	MR 17	C&K Coal Company	1.8E+07	7/23/93	4	0.03	0.09	0	0	164	6.8
	MR 17	C&K Coal Company	1.8E+07	6/30/94	30	0.04	0.17	0.1	0	168	6.8
	MR 17	C&K Coal Company	1.8E+07	7/31/95	*	1.33	0.209	0.588	0	176	*
	MR 17	C&K Coal Company	1.8E+07	3/12/96	*	< 0.3	0.071	< 0.5	0	48	*
	MR 17	C&K Coal Company	1.8E+07	5/30/96	*	< 0.3	< 0.05	< 0.5	0	86	*
	MR 17	C&K Coal Company	1.8E+07	7/25/96	*	< 0.3	< 0.05	< 0.5	0	82	*
	MR 17	C&K Coal Company	1.8E+07	7/17/97	*	0.134	0.033	0.185	0	104	*

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	MR 17	C&K Coal Company	1.8E+07	9/3/97	*	< 0.3	0.055	< 0.5	0	172	*
	MR 14	C&K Coal Company	1.8E+07	Jan-89	36	0.16	0.19	0	8	3	6.3
	MR 14	C&K Coal Company	1.8E+07	Apr-89	350	0.08	0.04	0.1	3	5	6.1
	MR 14	C&K Coal Company	1.8E+07	May-89	350	0.1	0.11	0.2	9	5	6.1
	MR 14	C&K Coal Company	1.8E+07	Jun-89	350	0.19	0.23	0.1	0	11	6.6
	MR 14	C&K Coal Company	1.8E+07	Jul-89	200	1.33	2.69	0.1	0	24	6.7
	MR 14	C&K Coal Company	1.8E+07	Aug-89	50	1.05	3.1	0.1	0	36	6.9
	MR 14	C&K Coal Company	1.8E+07	12/8/89	40	0.1	0.25	0.1	0	6	7.2
	MR 14	C&K Coal Company	1.8E+07	2/19/90	4	0.05	0.13	0.1	2	3	6.8
	MR 14	C&K Coal Company	1.8E+07	6/5/90	35	0.48	1.43	0.1	0	16	6.8
	MR 14	C&K Coal Company	1.8E+07	8/9/90	40	1.8	2.51	0.1	0	27	7
	MR 14	C&K Coal Company	1.8E+07	11/29/90	300	1.11	1.54	0.1	0	13	7.3
	MR 14	C&K Coal Company	1.8E+07	2/28/91	250	0.59	0.63	0.1	0	15	7.1
	MR 14	C&K Coal Company	1.8E+07	6/10/91	8	1.59	0.61	0.1	0	55	6.5
	MR 14	C&K Coal Company	1.8E+07	7/9/91	28	3.52	2.16	0.3	0	34	6.2
	MR 14	C&K Coal Company	1.8E+07	12/5/91	190	0.41	1.07	0.6	6	2	6.7
	MR 14	C&K Coal Company	1.8E+07	2/6/92	18	0.59	1.04	0.1	8	5	6.9
	MR 14	C&K Coal Company	1.8E+07	4/13/92	55	0.33	0.47	0.2	9	2	6.7
	MR 14	C&K Coal Company	1.8E+07	8/4/92	1	0.56	3.54	0.3	0	39	7
	MR 14	C&K Coal Company	1.8E+07	12/2/92	50	1.3	0.48	0.1	9	8	7
	MR 14	C&K Coal Company	1.8E+07	3/8/93	*	0.92	0.86	1	0	16	7.9
	MR 14	C&K Coal Company	1.8E+07	4/7/93	375	0.42	0.2	0.2	0	28	6.1
	MR 14	C&K Coal Company	1.8E+07	6/30/94	1	0.25	1.33	0	0	0	6.8
	MR 14	C&K Coal Company	1.8E+07	7/31/95	*	0.887	0.199	< 0.5	0	52	*
	MR 14	C&K Coal Company	1.8E+07	5/31/96	*	0.913	0.924	< 0.5	0	38	*
	MR 14	C&K Coal Company	1.8E+07	7/25/96	*	0.811	0.69	< 0.5	0	24	*
	MR 14	C&K Coal Company	1.8E+07	6/17/97	*	1.26	0.946	0.462	0	60	*
				Average =	168.11	0.53	0.65	0.19	0.98	52.33	6.89
				StDev =	183.73	0.64	0.94	0.25	2.61	48.85	0.50
LMR5	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	2/1/81	5000	3.56	1.61	*	58	1.61	
(historical)	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/12/81	1300	1.47	2.74	*	25	2.74	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	8/6/81	350	0.14	0.2	*	6	0.2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	11/1/81	650	2.2	3.4	*	9	3.4	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	2/15/82	650	2.23	2.89	*	16	2.89	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/1/82	250	2.4	2.77	*	494	2.77	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	8/4/82	650	1.27	3.94	*	8	3.94	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	10/31/82	200	2.6	6.97	*	107	6.97	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	3/22/83	1200	1.4	1.01	*	100	1.01	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	5/20/83	1200	4.78	3.66	*	35	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	7/25/83	1000	8.47	7.68	*	79	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	11/29/83	2000	3.04	2.69	*	26	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	3/6/84	9999	6.6	4.7	*	59	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/7/84	1000	4.76	4.33	*	38	3	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	9/24/84	1000	15.47	9.72	*	113	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	11/13/84	750	9.71	7.56	*	84	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	3/12/85	2000	3.01	2.91	*	25	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/17/85	2000	4.68	5.52	*	59	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	8/13/85	1000	6.44	9.31	*	106	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	12/9/85	2000	6.88	4.06	*	40	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	2/26/86	2000	3.88	3.3	*	22	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	5/6/86	2000	4.93	5.52	*	37	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	9/24/86	2000	2.35	4.98	*	39	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	12/22/86	9999	3.2	3.6	*	28	18	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	3/2/87	2000	2.79	2.75	*	22	1	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	5/29/87	2000	4.7	5.2	*	34	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	9/3/87	2000	9.9	9.3	*	82	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	12/7/87	2000	4.45	3.68	*	13	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	3/24/88	2000	5.3	4.29	*	31	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	5/12/88	2000	3.11	4.07	*	27	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	8/12/88	1000	6.85	10.61	*	91	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	11/21/88	2000	3.58	3.06	*	31	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	2/8/89	2000	5.51	3.46	*	12	1	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/1/89	2000	4.51	4.41	*	21	1	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	9/7/89	2000	11.49	11.14	*	89	0	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	12/14/89	2000	6.21	5.01	*	52	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	2/19/90	2000	4.07	2.94	*	17	2	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/4/90	1000	5.86	4.93	*	33	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	2/28/91	1000	6.58	5.01	*	38	0	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	6/11/91	1000	14.77	10.7	*	74	0	
	MR 15	C&K Coal Company	1.8E+07	1/1/89	4200	3.86	2.57	0	15	3	
	MR 15	C&K Coal Company	1.8E+07	Apr-89	5000	4.99	4.4	5.1	35	1	
	MR 15	C&K Coal Company	1.8E+07	May-89	8500	3.7	2.74	2.5	18	3	
	MR 15	C&K Coal Company	1.8E+07	Jun-89	8000	4.44	4.38	3.7	14	1	
	MR 15	C&K Coal Company	1.8E+07	Jul-89	7000	6.17	6.67	6.2	35	0	
	MR 15	C&K Coal Company	1.8E+07	Aug-89	6000	6.84	6.48	5.6	27	1	
	MR 15	C&K Coal Company	1.8E+07	12/8/89	5000	6.26	5.11	2.5	35	0	
	MR 15	C&K Coal Company	1.8E+07	2/19/90	8000	4.12	3.01	0.8	17	1	
	MR 15	C&K Coal Company	1.8E+07	6/5/90	4200	6.48	8.33	0	69	0	
	MR 15	C&K Coal Company	1.8E+07	8/8/90	1000	6.49	6.71	5.3	54	0	
	MR 15	C&K Coal Company	1.8E+07	11/29/90	1000	7.8	6.9	5.7	71	0	
	MR 15	C&K Coal Company	1.8E+07	2/28/91	1000	6.52	4.95	1.8	39	0	
	MR 15	C&K Coal Company	1.8E+07	6/10/91	1000	7.04	5.16	0.6	29	0	
	MR 15	C&K Coal Company	1.8E+07	7/15/91	1000	0.27	9.19	1.4	26	1	
	MR 15	C&K Coal Company	1.8E+07	12/5/91	1000	5.76	3.29	0.5	18	0	
	MR 15	C&K Coal Company	1.8E+07	2/6/92	1000	5.05	1.88	0.5	10	3	
	MR 15	C&K Coal Company	1.8E+07	4/13/92	1000	3.3	1.36	0.1	18	0	
	MR 15	C&K Coal Company	1.8E+07	8/4/92	1000	4.81	3.86	0.5	15	0	
	MR 15	C&K Coal Company	1.8E+07	12/2/92	1000	2.62	1.39	0.2	11	3	
				Average =	2442.34	5.11	4.81	2.26	48.07	1.60	
				StDev =	2436.00	2.96	2.56	2.26	65.50	2.57	
LMR5 (pipeline)	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	11/8/94	*	19.1	10.2	7.37	82	9.4	
	CAR 12	Cambria Coal Co. (C&K Coal)	1.8E+07	1/4/95	*	13	5.25	4.02	38	22	
	MR 15	C&K Coal Company	1.8E+07	3/8/93	2000	6.59	2.91	1	6	8	
	MR 15	C&K Coal Company	1.8E+07	4/7/93	1000	1	0.75	0.1	0	14	
	MR 15	C&K Coal Company	1.8E+07	7/23/93	1500	0.03	4.23	0	56	8	

TMDL Point	Study Point	Company	Permit #	Date	Flow *	Fe **	Mn **	Al **	Acid **	Alk **	pH
	MR 15	C&K Coal Company	1.8E+07	6/30/94	*	7.31	7.56	2.7	14	8	
	MR 15	C&K Coal Company	1.8E+07	5/30/96	*	7.08	4.04	3.88	26	14.6	
	MR 15	C&K Coal Company	1.8E+07	7/17/97	*	5.6	2.45	1.16	13.4	28	
				Average =	1500.00	7.46	4.67	2.53	29.43	14.00	
				StDev =	500	6.1818	3.006	2.5077	27.94	7.46	

TMDL points with the modifier "historical" are those data collected before 1993; TMDL points with the modifier "pipeline" are those data collected after construction of a pipeline to eliminate AMD in Comfort Run by the Bureau of Abandoned Mine Reclamation in 1993.

** All flow measurements are shown in units of gallons per minute (gpm).*

** All concentration measurements are shown in units of milligrams per liter (mg/l).*

Attachment G

Comments and Responses

Comments/Responses on Morris Run Watershed TMDL

EPA Region III Comments

Comment:
The mileage for the listed Little Muddy Run, stream code 26246, goes from 4.5 to 18.85 to 5.07, please explain. It should also be noted that the draft 2000 section 303(d) list identifies all impaired waterbodies as having been on the 1996 section 303(d) list and one segment on DEP's web version of the draft 2000 section 303(d) list is not included in Table 1.

Response:
Attachment A explains the difference in stream segment mileage between different versions of the 303(d) list. Changes have been made to Table 1 to show how segments appear on the 1996, 1998, and draft 2000 303(d) lists.

Comment:
The "Watershed Background" section refers to many large tunnel discharges. Please note the locations of any known tunnel discharges, besides the Brookwood Shaft, on the map and indicate whether or not there is any monitoring data.

Response:
The existence of other discharges is based on historical records. However, the historical records did not give location information. Therefore, locations of these discharges are not known. In addition, no data are available for these other discharges in historical records.

Comment:
Calculating the TMDL for LMR2 instead of UNT1 utilizes the assimilative capacity of the flow from unimpacted LMR1 to meet water quality standards at LMR2 without ensuring Comfort Run will meet water quality standards. Therefore, calculate the TMDL at UNT1 in addition to, or in lieu of, the TMDL at LMR2.

Response:
A TMDL has been calculated for point UNT1.

Comment:
Net alkalinity for sample points LMR2 and LMR4 is greater than zero yet acidity reductions are called for at these locations. Review of the @RISK portion of the spreadsheet discloses an alkalinity "standard" of 17.75 was used which does not match any average alkalinity values in Appendix E. Confirm that the average alkalinity values for the point at which the TMDL is being developed are specific to that point.

Response:
The alkalinity standard used for each point in the TMDL analysis is the instream alkalinity available at that point from water quality monitoring data. This standard varies at each point depending on the instream alkalinity at that point. Because alkalinity was greater than acidity at LMR2 and pH was maintained between 6.0 and 9.0, it was determined that pH standards were being met at LMR2 and therefore, pH impairment was not addressed at LMR2. The 99th percentile value from Monte Carlo analysis was determined at point LMR4 to be net acidic. Therefore, acidity at LMR4 needed to be reduced to the pH standard for that point (the alkalinity measurement at LMR4). Therefore, although LMR4 seems to be net alkaline when comparing the average data, acidity reductions based on the 99th percentile acidity were necessary.

Comment:
Little Muddy Run is listed for pH but a reduction in acidity was not calculated at LMR3 because of a lack of data. Confirm that no field pH readings were taken at Sample Point 2 from 1993 to 1995.

Response:
Field pH readings from LMR3 show that the pH ranges from 5.7 to 6.5, with an average of 6.17. Because LMR3 is meeting pH standards on average, it assumed that Little Muddy Run is net alkaline at LMR3. Therefore, analysis to address pH impairment at LMR3 is unnecessary.

Comment:
Please describe the Janesville Dam located between LMR3 and LMR4, *e.g.*, type, approximate height, volume, surface area, etc. The map in Appendix A could indicate that it is a side-channel dam by the way the impacted waterbodies are identified. Confirm whether or not the impoundment is a section 303(d) listed waterbody. The dam may or may not have an effect on the value of the downstream TMDL.

Response:
Data are not currently available concerning the volume and surface area of the impoundment created by the Janesville Dam. It is not a section 303(d) listed waterbody on either the 1996, 1998, or draft 2000 303(d) lists and currently is stocked with salmonids by the Pennsylvania Fish and Boat Commission. Other data concerning the dam has been added to the Little Muddy Run document text.

Comment:
As no wasteload allocations for future growth were included in these TMDLs, confirm that if additional mining is pursued within the watershed, the mining company will be required to meet water quality standards noted in Table 2 for any discharges from the mine site.

Response:
Mining permits are pending for the East Branch Little Muddy Run Watershed. The TMDL analysis done for this sub-watershed showed that although the two stream segments were listed as impaired due to AMD, data at the EB1 point show that no reductions are necessary, except for aluminum, and that these stream segments are actually attaining water quality criteria, with the exception of aluminum.

Provisions were added into the TMDLs for point EB1 to allow for future mining in the sub-watershed containing EB1. This was done by adding 15% to the mean and standard deviation used for @Risk analysis. The long-term average concentrations for EB1 with allowances for future mining were determined. Interestingly, point EB1 would still meet water quality standards 99 percent of the time even with a 15 percent increase in concentration at that point, except for aluminum. This extra 15 percent increase in concentration allows for future mining to occur in this sub-watershed.

Comment:
Table 21, which lists allowable loads at stations LMR2 through LMR5, EB1 and UNT2, does not relate back to the various segments listed on the 303(d) Lists. Please add stream segment numbers to aid in the tracking of which tributaries have their own TMDLs, and descriptions of the points along Little Muddy River to aid in implementation of this TMDL.

Response:
The description of each TMDL point is given in a narrative before the table containing allocations for that point. In addition, stream segment numbers have been added to the watershed map to aid in identification of segments and how they relate to TMDLs calculated at certain points.

Comment:
In order for the East Branch Little Muddy Run UNT to be approved as a separate TMDL, it must have its own allocation. Also, the UNT receiving the Brookwood Shaft discharge is presumed to be listed on the draft 2000 section 303(d) list, and will need its own TMDL. DEP may choose to develop TMDLs for these listed segments in the future.

Response:
A separate TMDL was calculated for the East Branch Little Muddy Run. Allocations to the UNT receiving the drainage from the Brookwood Shaft are included with point LMR5, which allocates loads to all points between LMR4 and LMR5, including the unnamed tributaries that drain into Little Muddy Run in this reach.