WRI46 - Assessing Extent and Longevity of Degradation Following Coal Mining in West Virginia

Final Report

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Summary of Accomplishments

Background:

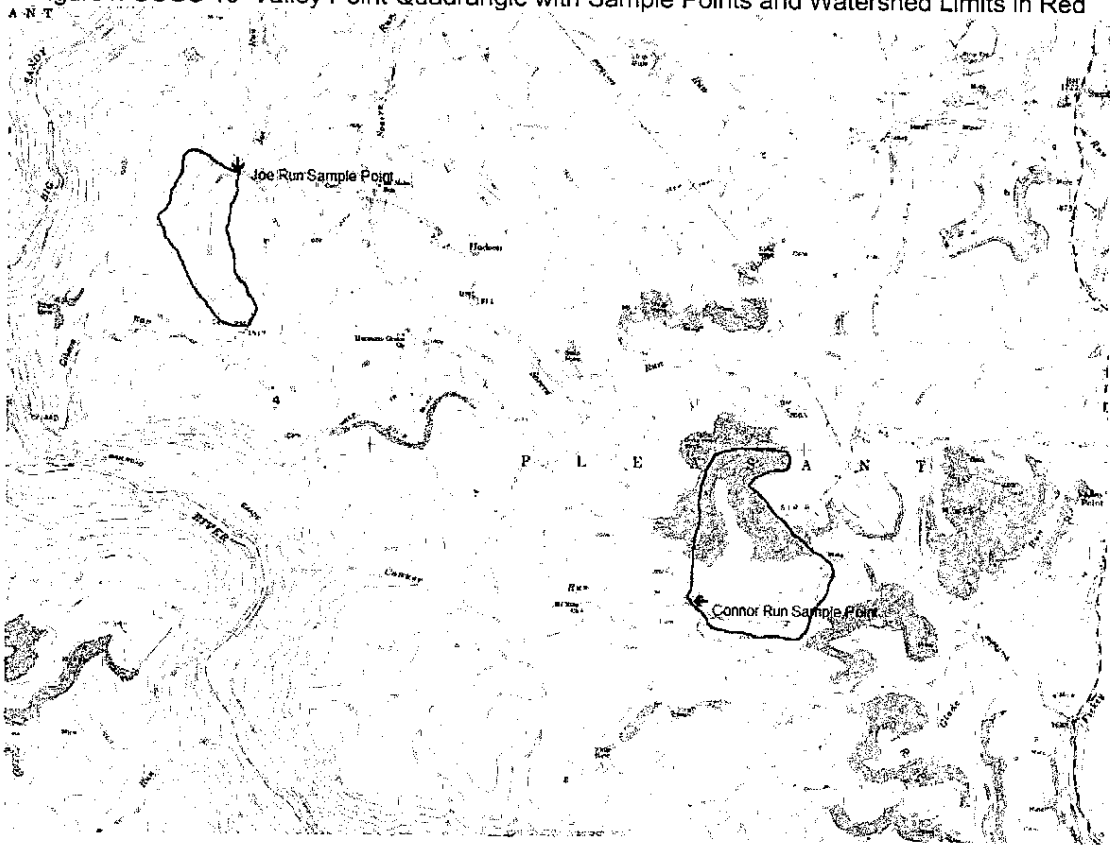
Coal mining has been a significant cause of long-term harm to streams in the Appalachians. However, a recent study at West Virginia University has shown that many of these acid impacted streams may be improved over time through the natural reduction in acid generation of the mine sources.

The purpose of this study was to compare two watersheds of similar size and geology, one of which was affected by acid mine drainage due to surface mining and the other of which was unmined. The mining that occurred in the mined watershed was to have been conducted at least 20 to 25 years previously and no mining was to have occurred since that time. The goal was to compare water chemistry and benthic macroinvertebrate life to determine how much, if any, natural amelioration of acid mine drainage has occurred in the mined watershed over time. Based on the lack of un-mined, undisturbed watersheds since the initial study, it was decided that we use an impacted watershed from the USFS study and an unimpacted watershed that was not used in the initial study. Due to these circumstances, our results and conclusions will be based on the hypothesis that the unmined watershed would have undergone little to no change in the last 20 to 25 years.

The benthic survey was conducted to develop correlations between chemical parameters and stream re-colonization. The data used for the past water chemistry was from the 1982 report "Stream Water Quality in the coal region of West Virginia and Maryland" produced by the US Forest Service. The streams chosen for this comparison are the upper sections of Connor Run and Joe Run, both located in Preston County. The impacted watershed, Connor Run, (no. 9212 in the Forest Service study) was surface mined from 1955 to 1979. The samples were collected at both sites on May 23, 2003. It should also be noted that the sample for Connor Run was collected at the approximate location where the US Forest Service Samples were collected.

Connor Run and Joe Run are both located in Preston County in north-central West Virginia. Both watersheds are shown in entirety on the Valley Point 7.5 minute USGS quadrangle. The topography of the area consists of an upland plateau of rolling hills that is well dissected by the larger regional streams and rivers that form well developed canyons. Figure 1 is a portion of the Valley Point Quadrangle detailing both sample locations and their respective watersheds.

Figure1. USGS 15' Valley Point Quadrangle with Sample Points and Watershed Limits in Red



Overall, Connor Run, the mined watershed, comprises a larger watershed than Joe Run. However, the sampling location was located in the upper reaches of the watershed along County Road 14/5. The drainage area above the sampling location is approximately 360 acres (map determined). Connor Run is a direct tributary to the Cheat River. While it has carved a fairly well defined, high gradient canyon as it approaches the Cheat, the upland area where the stream was sampled was of a fairly low gradient nature, with evidence of some wetland type vegetation in areas along the stream margins. The stream gradient was approximately 60 feet per mile. The relief in the sub-section of Connor Run being studied is approximately 126 vertical feet (map determined). It is possible that the historical relief and topography of the area may have been altered slightly by the surface mining.

Joe Run was sampled approximately 0.3 of a mile from its confluence with Big Sandy Creek just below the crossing of County Road 14/8. While Joe Run is a smaller watershed, the sampling point chosen represents the influence of a larger drainage area than that for Connor Run. The drainage area above the sampling point on Joe Run was approximately 560 acres. The gradient of approximately 170 feet per mile and relief of approximately 441 vertical feet was greater than that of the Connor Run sub-watershed being studied.

Both sub-watersheds represented a similar mixture of forested and open land. There was some evidence of relatively recent logging in both sub-watersheds. A high power electrical transmission line transects the Connor Run sub-watershed close to the sampling location. However, there was no evidence of use of herbicides for right-of-way clearing. The tree canopy appeared to be somewhat more open in the sampling area along Connor Run than it was in the sampling area along Joe Run. However, the canopy was not fully leafed out at the time of the sampling.

Methodology:

Water Sampling

Water sampling performed for the Joe and Connor Run watersheds involved the use of an Oakton pH meter to take pH readings. Flows were taken using a Marsh-McBirney flow meter. In addition to the pH and flow readings, two samples were collected at each site, one which was non-acidified and non-filtered, and the other acidified and filtered. The non-acidified, non-filtered samples were used for measurement of pH, acidity, alkalinity, Sulfates, total dissolved solids, and total suspended solids. The acidified, filtered samples were used for metals such as iron, aluminum, manganese, and magnesium. The pH and flows were recorded in a field book and the samples were sent off to Sturm Environmental Services, Inc., for analysis.

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected in an identical manner at both sites. Three sub-samples were collected at each site using a Wildco kick seine with a 500 µm mesh size. An area of approximately one square meter of stream bottom was disturbed on the upstream side of the seine in a riffle area with the current carrying the invertebrates into the net and holding them there. The seine was positioned at an approximately 45° angle. Once the sub-sample was collected the net was carefully removed from the stream in such a way as to not lose any organisms. Three replicate sub-samples were collected at separate riffles along the same stretch of stream.

The larger organisms were removed from the net using forceps and placed into labeled jars containing 70 percent isopropanol. Once the larger organisms were removed, the remaining organisms, along with any debris and sediment on the net, were carefully scraped using a metal ruler into a wide-mouth Mason jar, which was then filled with 70 percent isopropanol. The collected organisms were then taken back to the laboratory for identification and quantity. Figures 2 and 2a were photographs taken during the sampling event.

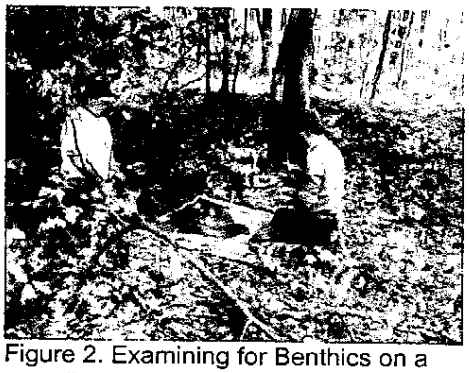


Figure 2. Examining for Benthics on a sampling screen on Connor Run.

Figure 2a. Collecting Benthics in the Sampling Screen on Joe Run.

Results:

Stream Chemistry

The stream chemistry for Joe and Connor Run differed greatly. The water samples collected from Joe Run (the unimpacted watershed) had a pH of 6.6 with an acidity of 1 mg/L while having an alkalinity of 11 mg/L. Iron, aluminum, manganese, and magnesium concentrations were <0.05 mg/L, <0.05 mg/L, <0.01 mg/L and 2.45 mg/L, respectively. These metals values are indicative of an un-impacted stream and are typical for Clean Streams in West Virginia.

Connor Run was very different. The sample collected had a pH of 3.4, an acidity of 121 mg/L, and an alkalinity of 0 mg/L. Metal concentrations in the sample had measured 3.75 mg/L for iron, 11.6 mg/L for aluminum, and 4.9 mg/L for manganese. Based on the sample collected from Connor Run, the stream is still being impacted by acid mine drainage. Table 1 is a chart showing water chemistry values for Joe and Connor Run.

As part of the study, data was taken from the US Forest Service report and compared to the present day sampling event to determine what, if any improvements had been made over the last 20 to 25 years. Even though there were approximately 21 samples taken during the 1978-79 study, we used the data that had calculated lab acidity. This was done so that actual acidities could be compared and not estimated acidities which use pH, iron, aluminum, and manganese concentrations. Table 2 is a comparison of the selected samples from the 1978-79 study with the 2003 sampling event.

The data compiled from Connor Run in 1978-79 has an average pH of 2.96, an average estimated acidity of 321 mg/L, and 0 mg/L of alkalinity. Metal concentrations had an average value of 25 mg/L for iron, 31 mg/L of aluminum, 14 mg/L of manganese, as well as 30 mg/L of magnesium. Data from last years sampling event shows a pH increase to 3.4. The acidity decreased from 321 mg/L to 103 mg/L. There was still no alkaline generation in the stream. Metals in the sample also showed a significant decrease in concentration. Iron went from

25 mg/L in 78-79 to 3.75 mg/L, aluminum from 31 mg/L down to 11.6 mg/L, manganese from 14 mg/L to 14.9 mg/L and magnesium from 30 mg/L down to 16.5 mg/L.

Table 1. Water Chemistry for Connor and Joe Run

Sampling Station		Connor Run	Joe Run
date		5/23/2003	5/23/2003
Flow	gpm	305	536.7
pH		3.4	6.6
acidity	mg/L CaCO3	121	1
est. acidity	mg/L CaCO3	103	0
alkalinity	mg/L CaCO3	0	11
acid-alk	mg/L CaCO3	103	-11
acid load	tons/year	69	-12
TDS	mg/L	313	51
TSS	mg/L	2	2
Mg	mg/L	16.5	2.45
Fe	mg/L	3.75	0.05
Al	mg/L	11.6	0.05
Mn	mg/L	4.9	0.01
SO4	mg/L	197	16

In a 25 Year period, the acidity has decreased by 68%, iron, aluminum, manganese, and magnesium have seen decreases of 85%, 62.5%, 65%, and 52.8%, respectively. The pH has seen a dramatic improvement going from 2.96 in 78-79 to 3.4 in 2003. Acid load in Connor Run in 1978-79 had an average of 45.36 tons of acid per year. In the 2003 sampling, the acid load was approximately 69 tons per year. This higher acid load can be attributed to the higher flow. If you took the flow from the 1978-79 data and compared it with the 2003 sampling the acid load is only 18 tons per year, which would be a decrease of 60%.

Table 2. Water Quality For Site 9212 Preston County, West Virginia

Sampling Station		9212	9212	9212	9212	9212	9212	9212	9212	9212
date		10/18/1978	12/1/1978	2/14/1979	3/9/1979	5/31/1979	7/9/1979	10/24/1979	average	5/23/2003
Flow	gpm	40.39	134.63	44.88	67.3	67.3	22.44	180	79.56	305
pH		3	3	2.9	3	2.9	2.8	3.1	2.96	3.4
acidity	mg/L CaCO3	240	150	360	270	210	470	200	271.43	121
est. acidity	mg/L CaCO3	257	155	406	306	255	631	238	321.22	103
alkalinity	mg/L CaCO3	0	0	0	0	0	0	0	0.00	0
acid-alk	mg/L CaCO3	257	155	406	306	255	631	238	321.22	103
acid load	tons/year	23	46	40	45	38	31	94	45.36	69
TDS	mg/L	670	374	811	693	593	1420	639	742.86	313
TSS	mg/L	66	23	59	40	20	76	27	44.43	2
Mg	mg/L	28	18	37	27	27	43	30	30.00	16.5
Fe	mg/L	22	12	39	23	17	43	21	25.29	3.75
Al	mg/L	23	11	38	31	23	68	22	30.86	11.6
Mn	mg/L	11	6.5	15	12	10	32	11	13.93	4.9
SO4	mg/L	500	260	570	520	450	1100	460	551.43	197

Benthic Macroinvertebrates

Overall, the substrate in Joe Run tended to be better for collecting benthic macroinvertebrates. Riffle areas dominated by cobble size rocks are considered to be optimal habitat for collecting the widest diversity of benthic macroinvertebrates. Because of the higher gradient, Joe Run had more riffle areas than the area of Connor Run sampled. However, three near-optimal riffles were located along a roughly 100-meter section of Connor Run.

Connor Run, did however, contain noticeable iron sediments as part of the stream substrate. In some riffles, the iron sediment tended to fill some of the interstitial voids between rocks that form habitat for benthic macroinvertebrates. Also, during sampling on Connor Run, as the iron sediments were disturbed and carried into the net, they tended to clog the net. This caused the current to flow into and out of the net in something of an S-current, rather than to flow through the net as desired. This means that it is possible that some organisms were carried into and out of the net without being deposited and held on the net surface and that the total number of organisms recovered may represent less than the actual overall density of organisms. It is not expected however that this would have a significant effect, if any, on the number of taxa recovered.

Since there were no iron sediments evident in Joe Run, this type of clogging was not an issue. There tended to be more woody and leafy debris retained on the net in the Joe Run samples than in the Connor Run samples.

Benthic samples were processed by sorting the organisms from the debris and sediments. The larger organisms, which were removed by forceps and placed in small jars, were relatively easy to separate from the debris. The remaining material that was scraped from the net was sorted by taking a small amount of the material, about one teaspoon, and placing it in a shallow tray. The material was spread out in a thin layer and any visible organisms were separated and placed in a jar of alcohol. The tray was then scanned with a microscope until all smaller organisms were recovered. The remaining "scrapings" were similarly processed, one teaspoon at a time, until all organisms were recovered. Once all organisms were separated from the debris and sediment they were composited into one large collection for each sample site.

The quantification of the biological condition was conducted using the Stream Condition Index (SCI) methodology as developed for the West Virginia Division (now Department) of Environmental Protection by Tetra Tech, Inc. The methodology is described in "A Stream Condition Index for West Virginia Wadeable Streams" published in March 2000, and revised on July 21, 2000 by Tetra Tech.

The SCI is similar to other protocols such as Rapid Bioassessment Protocols (RBPs) or Invertebrate Condition Indexes (IBIs). These protocols use a series of

biological measurements, called metrics, which have been determined to be reflective of the structure and function of benthic macroinvertebrate assemblages in rocky-bottomed streams. The metrics have been shown to generally change in predictable ways in response to human influence. The metrics compare conditions found in sampled streams to those found in non-impaired streams called reference streams.

The West Virginia SCI uses six core metrics. Identification of organisms for calculation of the SCI is primarily at the family taxonomic level. The core metrics used for the SCI are:

- EPT taxa — EPT taxa are three taxonomic orders of insects that are generally considered to be sensitive to pollution. Although some are actually relatively pollution-tolerant, because most are sensitive the number of EPT taxa is expected to be higher in non-impaired streams. EPT stands for Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies).
- Total taxa — unpolluted streams are expected to have a greater diversity of organisms. The total number of taxa is expected to be higher in non-impaired streams.
- % EPT — the percentage of EPT organisms compared to the total number of organisms is expected to be higher in non-impaired streams.
- % Chironomidae — the percentage of Chironomidae (midge larvae) is expected to increase as human impacts increase.
- % Top 2 Dominant Taxa — the percentage of organisms represented by the two most numerous taxa is expected to increase as human impacts increase. That is, unhealthy streams are more likely to be dominated numerically by just one or two taxa of organisms.
- Hilsenhoff Biotic Index (HBI) — the HBI calculates a weighted average that represents the pollution sensitivity or tolerance for all of the organisms in a sample. A pollution sensitivity value on a 1 to 10 scale is assigned at the family level for each taxon. Lower numbers are considered to be more pollution-sensitive. The number of organisms within a given taxon is multiplied by the pollution-sensitivity value assigned to that taxon. Similar products are determined for each taxon. These are summed and divided by the total number of organisms to calculate an average pollution sensitivity number or HBI per organism. The HBI is expected to be higher in streams with higher human impacts.

The SCI uses standard or "best values" based on characteristics found in West Virginia references streams. Best values are based on either 5th or 95th percentile values, depending on the metric, calculated for 1268 benthic samples collected in West Virginia references streams form 1996 to 1998.

For this study, all organisms recovered were identified to get a total list of organisms recovered and their relative numbers. After all organisms were

identified, the two composited sample sets were randomly sub-sampled to get a 200-organism sub-sample for each as required by the SCI protocol. The calculations for each metric were then conducted on the 200-organism sub-samples.

The total number of taxa and the number of organisms within each taxon for Joe Run are listed below. EPT taxa are marked with appropriate initials.

Total Taxa and Number of Individuals Organisms Recovered from Joe Run:

Capniidae	362	(P)	Ephemeridae	11	(E)
			Chloroperlidae	8	(P)
Baetidae	303	(E)	Oligochaeta	7	
			Limnephilidae	6	(T)
Amelitidae	247	(E)	Perlidae	6	(P)
Ephemerellidae	148	(E)	Psephenidae	3	
Nemouridae	92	(P)	Lepidostomatidae	3	(T)
Heptageniidae	89	(E)	Rhyacophilidae	3	(T)
Leptophlebiidae	84	(E)	Sialidae	2	
Perlodidae	77	(P)	Peltoperlidae	2	(P)
Glossosomatidae	47	(T)	Hydrophilidae	2	
Elmidae	44		Philopotamidae	1	(T)
Tipulidae	26		Simuliidae	1	
Gammaridae	24		Chauliodinae	1	
Cambaridae	21		Ceratopogonidae	1	
Chironomidae (non-red)	15		Asellidae	1	
Hydropsychidae	13	(T)	**Total**	**1650**	

The total number of taxa and number of individuals recovered from Connor Run are shown below, with EPT taxa marked with appropriate initials.

Total Taxa and Number of Individual Organisms Recovered from Connor Run:

Chironomidae (red)	433	
Sialidae	25	
Capniidae	16	(P)
Dytiscidae	14	
Ceratopogonidae	2	
Perlodidae	1	(P)
Culicidae	1	
Total	**492**	

Sub-samples and Calculation of Metrics

The two sets of samples yielded the following random 200-organism sub-samples.

Joe Run:

Capniidae	50	(P)	Tipulidae	6	
Baetidae	32	(E)	Gammaridae	3	
Amelitidae	25	(E)	Cambaridae	4	
Ephemeridae	21	(E)	Hydropsychidae	2	(T)
Nemouridae	15	(P)	Oligochaeta	1	
Heptageniidae	10	(E)	Perlidae	1	(P)
Leptophlebiidae	9	(E)	Psephenidae	1	
Perlodidae	12	(P)	Sialidae	1	
Glossosomatidae	4	(T)	**Total**	**200**	
Elmidae	3				

Connor Run:

Chironomidae (red)	178	
Sialidae	9	
Capniidae	7	(P)
Dytiscidae	5	
Ceratopogonidae	1	
Total	**200**	

EPT taxa calculations — The standard or best value for EPT taxa is 13. That is, West Virginia reference streams would be expected to have 13 EPT taxa (family level) at the 95th percentile level and this number would decrease with stress. The metric score is 100 (X/13), where X is the metric value determined from the 200-organism sub-sample.

Eighteen EPT taxa where recovered from Joe Run. Once sub-sampled to 200 organisms, 11 EPT taxa remained. 100 (11/13) = 84.6.

Only two EPT taxa were recovered from Connor Run. Once sub-sampled, only one EPT taxon remained. 100 (1/13) = 7.7

Total taxa calculations — The standard or best value for total taxa is 21. West Virginia reference streams would be expected to have 21 total family level taxa at the 95th percentile level and this number would decrease with stress. The metric score is 100(X/21), where X is the metric value determined from the 200-organism sub-sample.

Thirty-one total taxa were initially recovered from Joe Run. Upon sub-sampling this number was reduced to 18 taxa. 100 (18/21) = 85.7

Seven taxa were originally recovered from Connor Run. Upon sub-sampling this number was reduced to five taxa. 100 (5/21) = 23.8.

Percent EPT calculations — The best value for percent EPT is 91.9 percent. West Virginia reference streams would be expected to have 91.9 percent EPT taxa at the 95th percentile level and this percentage would decrease with stress. The metric score is
100 (X/91.9), where X is the metric value determined in the sub-sample.

For Joe Run, 181 of the 200 organisms, or 90.5 percent, were EPT taxa. 100 (90.5/91.9) = 98.5.

For Connor Run, seven of the 200 organisms or 3.5 percent were EPT taxa. 100(3.5/91.9) = 3.8.

Percent Chironomidae calculations — The best value for percent Chironomidae is 0.98 percent. West Virginia reference streams would be expected to have 0.98 percent Chironomidae at the 5th percentile level and this percentage would be expected to increase with stress. The metric score is 100 [(100 - X) / (100 - 0.98)], where X is the metric value determined for the sub-sample.

For Joe Run, while there were 15 Chironomidae in the complete sample, there were none in the 200 organisms sub-sample. 100(100/99.02) = 100. Note that a score for any individual metric cannot exceed 100, even if the value for the sample exceeds the best value for a metric.

For Connor Run, 89 percent of the organisms in the sub-sample were Chironomidae.
100 [(100-89) / (100-0.98) =
100 (11/99.02) = 11.1

Percent Top 2 Dominant Taxa calculations — The best value for this metric is 36.9 percent. At the 5th percentile, West Virginia reference streams would be expected to have the two most numerous family level taxa make up 36.0 percent of the sample and this percentage would be expected to increase with stress. The metric score is
100 [(100 - X) / (100 - 36.0)], where X is the value determined for the sub-sample.

For the Joe Run sub-sample, the top two dominant taxa were Capniidae with 50 individuals and Baetidae with 32 individuals. Together these two taxa comprised 41 percent of the sub-sample. 100 [(100 - 41) / (100 -36) =
100 (59/64) = 92.2.

For the Connor Run sub-sample, the top two dominant taxa were Chironomidae, with 178 individuals and Sialidae with 9 individuals. Together these two taxa comprised 93.5 percent of the sub-sample. 100 [(100 - 93.5) / (100 - 36)] = 100 (6.5/ 64) = 10.2.
Hilsenhoff Biotic Index calculations — The best value for this metric is 2.9. At the 5th percentile level, West Virginia reference streams would be expected to have an HBI value of 2.9 and this number would be expected to increase with stress. The metric score is 100 [(10-X) / (10 - 2.9)], where X is the value determined for the sample.

For Joe Run the HBI is calculated as shown below

Taxa	# of organisms	HBI Value	# of organisms x HBI value
Capniidae	50	1	50
Baetidae	32	4	128
Amelitidae	25	4	100
Ephemerellidae	21	1	21
Nemouridae	15	2	30
Heptageniidae	10	4	40
Leptophlebiidae	9	2	18
Perlodidae	12	2	24
Glossosomatidae	4	0	0
Elmidae	3	4	12
Tipulidae	6	3	18
Gammaridae	3	6	18
Cambaridae	4	6	24
Hydropsychidae	2	4	8
Oligochaeta	1	8	8
Perlidae	1	1	1
Psephenidae	1	4	4
Sialidae	1	4	4
Totals	200		508

508/200 = 2.5

100 [(10 - 2.5) / (10 - 2.9) =
100 (7.5/ 7.1) = 100 Note that even though the HBI calculation exceeded 100, the maximum score of 100 was used.

For Connor Run the HBI is calculated as shown below.

Taxa	# of organisms	HBI Value	# of organisms x HBI value
Chironomidae	178	8	1424
Sialidae	9	4	36
Capniidae	7	1	7

Dytiscidae	5	5	25
Ceratopogonidae	1	6	6
Totals	200		1498

1498/200 = 7.5

100 [(10 - 7.5) / (10 - 2.9)] =
100 (2.5/7.1) = 35.2

The final SCI score is an average of each of the six metrics. The overall SCI scores for Joe Run and Connor Run are averaged below.

Metric	Joe Run	Connor Run
EPT Taxa	84.6	7.7
Total Taxa	85.7	23.8
% EPT	98.5	3.8
% Chironomidae	100.0	11.1
% Top 2 Dominant Taxa	92.2	10.2
HBI	100.0	35.2
Totals	561.0/6	91.8/6
SCI Score	93.5	15.3

Conclusions:

Water Chemistry

Based on the water samples collected on Joe Run, there is no reason to believe that the stream chemistry has changed much over the last 25 years. This is due to the fact that there has never been any mining in the watershed and that its location does not allow easy access onto the stream. The samples revealed a pH of 6.6 with virtually no acidity and approximately 11 mg/L of alkalinity. As far as metals concentrations in the channel, there was no iron, aluminum, or manganese. However, there was 2.45 mg/L of magnesium which is typical of streams around the state.

From the sampling done on Connor Run, it is apparent that the data collected in 2003 represents a significant change in the water chemistry since the initial

sampling 25 years ago. The 2003 sample displayed a significant increase in pH from 2.96 to 3.4, while having a decrease in acidity from 321 mg/L during the last study to 103 mg/L for the 2003 sampling event. Figures 3 and 3a are graphical representations of the pH and acidity on Connor Run for the 1978-79 sampling event compared to the 2003 sampling event. These graphs were generated by taking the seven sampling events from the USFS study and comparing them to the single sampling event in 2003.

Figure 3. Acidity Values for 1978-79 data v/s 2003 sampling event

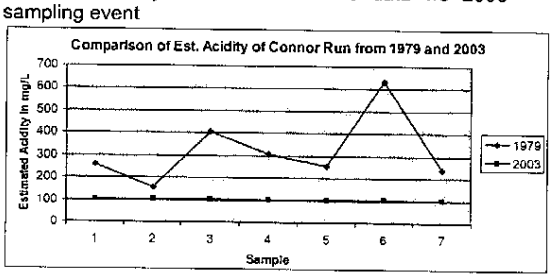
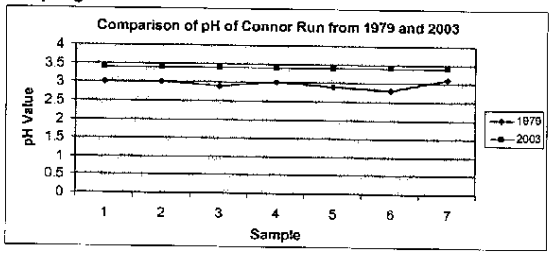
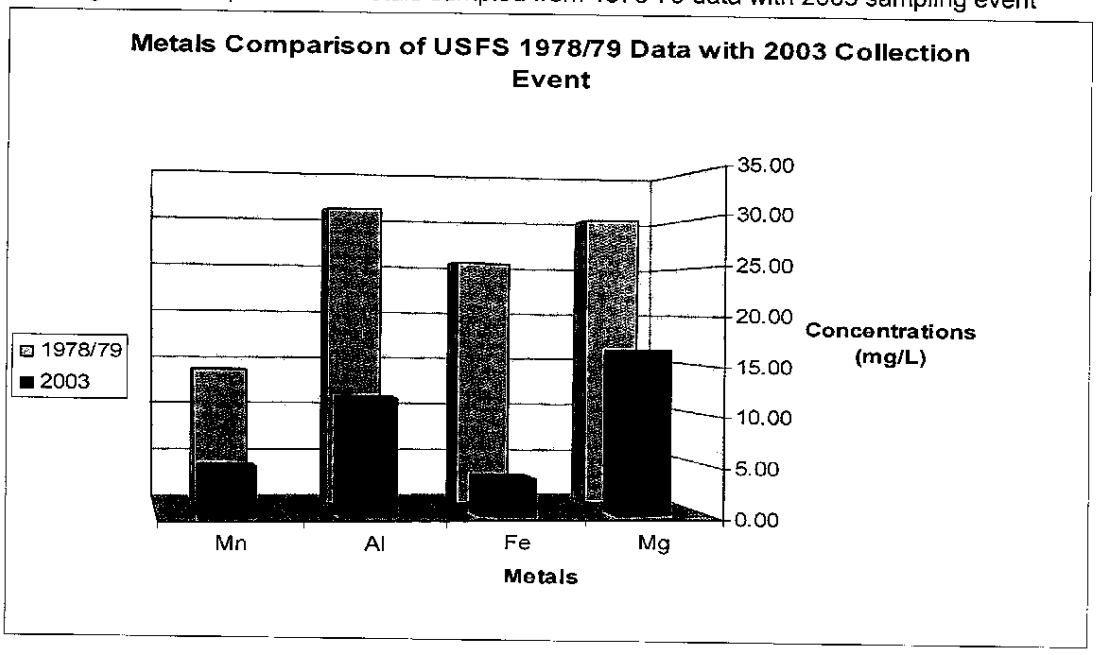


Figure 3a. pH values for 1978-79 data v/s 2003 sampling event



Metals concentrations on Connor Run have been reduced an average of 62.3%. Of the metals sampled, iron had the greatest reduction at 85% and magnesium had the least at 52.8%. Figure 4 is a graphical representation of the metals data respective to their change over time. This graph was made by using the average of the seven sampling events done in 1978-79 and compared against the one sampling event taken in 2003. The red indicates the 2003 sampling event while the blue represents sampling done in 1978-79.

Figure 4. Comparison of metals sampled from 1978-79 data with 2003 sampling event



Based on this data, amelioration of an acid impacted stream does occur over time. The extent to which reduction occurs will be dependent on the original AMD chemistry as well as the depositional environment in which the degradation occurs.

Benthic Macroinvertebrates

The final SCI scores of 93.5 for Joe Run and 15.3 for Connor Run demonstrate a wide difference in the stream quality of the two streams as reflected in their respective benthic macroinvertebrate assemblages. The higher the SCI, the more similar stream conditions are to those found in West Virginia reference streams. At 93.5, Joe Run shows good similarity to West Virginia reference stream conditions. At 15.3, Connor Run shows little similarity to West Virginia reference stream conditions or to Joe Run. The scores indicate that any natural amelioration that may have taken place was, from a perspective of benthic macroinvertebrate life, minimal. To get a better idea of over what time span natural recovery of benthic life occurs it would be necessary to compare a stream such as Connor Run to itself over time as well as to a reference quality stream. Unfortunately, no historical record of benthic macroinvertebrate life is documented for upper Connor Run so it is not possible to tell if the benthic life currently found in the stream represents a slight improvement over earlier post-mining conditions.