

### Introduction

Historic mining activity within the state of Pennsylvania has led to the contamination of numerous waterways throughout the coal mining regions. This contamination occurs when water passes through altered coal stratigraphy or abandoned mine waste and then discharges to our waterways. The oxidation and precipitation of metals associated with the chemical constituents of bituminous coal is one impact of abandoned mine drainage. The most common reaction associated with AMD is the weathering of pyrite ( $\text{FeS}_2$ ). During this process oxidation of the pyrite leads to Ferric Hydroxide precipitation and frequently a lowered water pH. This reaction gives rise to the visible rust-colored stain within streams, which is often referred to as yellowboy. Also, metals such as aluminum and manganese may be present in AMD discharges. The occurrence of these metals, their precipitates, and associated chemical reactions can lead to degraded water quality in previously mined areas.

Fox Run, located in Mercer County, has been impacted by historic mining activities. It has been identified as impacted by metals from AMD by the PA DEP in the 2000 303(d) List of Waters. In 1999 the Mercer Conservation District began a study to identify the impact of mining activities on Fox Run. The watershed was first deep mined circa 1900. In the 1980s Adobe Coal Company and the FW & RR Incorporated surface mined coal within the watershed. The survey conducted by the District during 1999 and 2000 sought to accomplish three things: locate and inventory the discharges to Fox Run on previously mined land, quantify the physical and chemical attributes of those discharges, and identify the zone of influence on impacted stream reaches. The remainder of this paper will describe the materials and methods used to collect the data and what the results imply. Finally, the District will propose a possible treatment option for the restoration of Fox Run.

### Materials and Methods

Discharge measurements were performed twice each month on twelve locations in the watershed. These measurements were taken to provide average flow rates of Fox Run and contributing springs/seeps. To begin, weirs were placed on identified discharges that could be captured in a channel (overland discharges and seeps were excluded from this process). The channel served to provide an area for a standing pool of water to develop behind the weirs and accommodate discharge measurement. The weirs were constructed in the field and installed with the assistance of the Pennsylvania Conservation Corps. Both V-notch and rectangular notch weirs were constructed of 2X4-lumber and 1/2 inch exterior plywood. Measurements were taken by determining the height of water above the notch with a carpenter's rule (H). These measurements were made on the upstream side of the weir. The following equations were then used to determine the discharge rates in cubic feet per second: V-notch =  $2.5H^{5/2}$

$$\text{Rectangular notch} = 3.33 [\text{width of notch in feet} - (0.2H)] H^{3/2}$$

This discharge rate was then converted and subsequently reported in gallons per minute. In addition to the weirs, a Price type-AA current meter was employed to sample the discharge rates at four locations on the main branch of Fox Run. The stream was first cross-sectioned with a line and markers were placed in locations to achieve transects of flow across the cross section. These markers were located to try to obtain measurable partitions of flow that made up no more than 10% of the total cross sectional flow at the sampling location. The current meter was then utilized to obtain a number of clicks (representing one revolution of the sampling device) per second. These clicks were measured over a time period which averaged 40 seconds. Measurements began at the end of one revolution and were measured for an elapsed time to the end of a revolution and recorded to the nearest second. The following equation was then used to obtain a velocity of flow in feet per second at each transect:  $[2.2048(\text{revolutions/second}) + 0.0178]$ . The area (in square feet) of each transect was then determined and the overall discharge at that location was obtained by the following equation:  $[\text{SUM}(\text{area 1} \times \text{velocity 1}) + (\text{area 2} \times \text{velocity 2}) \dots]$ . The resulting discharge rate in cubic feet per second was then converted and subsequently reported in gallons per minute. The Pennsylvania Conservation Corps assisted in the collection of discharge data during the project.

Three additional parameters were collected during the District's survey of Fox Run. Chemical, biological, and location data were also collected. Chemical samples were collected once a month and

analyzed by C and G Coal Analysis Labs of Summerville, Pennsylvania. Two samples were collected at each of the twelve locations and immediately refrigerated for shipment to the lab. The samples were collected in the stream of water discharging from the weirs and also in the middle of the stream. During the collection of the samples, a field pH and temperature were taken with a YSI 60 pH meter. The meter was calibrated the morning of each sampling event using standard solutions of pH 7, 4.01, 10.01. Biological monitoring was performed using the Save Our Streams protocol developed by the Isaak Walton League of America. Sampling for this parameter was done a total of six times during the survey. Aquatic macroinvertebrate sampling was performed as close to the four main stem discharge locations as possible. The sites were selected for proximity to the discharge sampling locations and suitable habitat. Again, Pennsylvania Conservation Corps members and members of Trout Unlimited assisted in the data collection. Finally, a latitude and longitude for all monitoring locations and the locations of spring/seeps that could not be captured for measurement were sampled using a Magellan 320 Global Positioning System.

### Results/Conclusions

Fox Run is a perennial stream that derives its base flow from springs, which display evidence of continued influence of historical mining operations. Fox Run, by default, can be classified as a WWF (Warm Water Fishes) stream. In addition to various seeps there are three persistent springs which sustain Fox Run. The first instance of impact is noted at 80 07' 19" W longitude, 41 18' 06" N latitude. During the summer the waters above this spring completely vanished and only minimally appeared after substantial rainfall events. This discharge averaged 723.04 gallons per minute during the assessment. The average total iron content of this discharge was 6.63 mg/l. Statewide criteria indicate that a total daily maximum of this constituent be 1.5 mg/l for sustaining aquatic life and for use as a water supply. Evidence of the high iron content can be visually seen immediately from the spring in the form of iron precipitate that coats the streambed. The next spring that influences Fox Run is located at 80 07' 30" W, 41 17' 54" N. This spring also has a high iron content that averaged 6.65 mg/l. Additionally, manganese, sulfates, and total dissolved solid (TDS) exceeded state criteria for water supplies. A pungent sulfur odor and excess of iron precipitate distinguish this spring from the others. It averaged 84.47 gallons per minute discharge. There is no noticeable precipitation of manganese in the discharge watercourse. Lastly, is the spring located just off of State Route 62 at 80 07' 34" W, 41 17' 47" N. This spring averaged 20.19 gallons per minute discharge and 15.11 mg/l total iron. Manganese, sulfates, and TDS were also above outlined criteria for water supply on this discharge. Again, the iron precipitate and sulfur odors were apparent at this discharge. In addition to these major influences, numerous seeps line the right bank of Fox Run looking upstream from Route 62 (See Appendix A for Entire Data Set). These seeps extend from the previously mentioned spring upstream to the area near the second spring. This portion of the stream is lined with residual mine waste. The seeps appear on the stream banks where the hydraulic conductivity of the sediment permits it to escape. During the course of the investigation, one seep turned to overland flow. Further investigation uncovered three small seeps that originate approximately 300 feet from Fox Run. These seeps then overland flow to a low area behind the mine spoil where they collect and likely supply a large portion of the noticed stream bank seeps. It was not feasible to capture and measure these discharges due to a lack of channel development. (See map and Appendix B for details)

The primary "pollutant" in Fox Run is iron. Although other metals are present in Fox Run, the iron hydroxide precipitate is the cause of not only impacted aesthetics, but also is deleterious to macroinvertebrate habitat and species richness. The zone of AMD influence extends from 80 07' 19" W, 41 18' 06" N to 80 08' 07" W, 41 17' 25" N. Visual evidence of influence beyond this point is however evident and most likely can be correlated to flushes of the iron precipitate during storm events. The discharges and their metal content could likely be treated by three aerobic wetlands that capture and treat, at a minimum, the three major discharges. Metal removal would likely occur through bacterial activity and increased oxidation from atmospheric exposure. The current pH would facilitate precipitation of iron and manganese. An estimated size of each of three wetlands can be obtained by first calculating the pollutant loading rates of Acidity, Iron, and Manganese with the following equation:

$$[\text{Flow Rate} \times \text{mg/l concentration} (.012)] = \text{lb/day}$$

The maximum discharge and pollutant concentrations were used in this calculation. Next, the minimum wetland size was determined by using the following equation :

$$\left[ \frac{\text{Iron loading lb/day}}{180 \text{ lb/ac/day}} \right] + \left[ \frac{\text{Manganese loading lb/day}}{9 \text{ lb/ac/day}} \right] + \left[ \frac{\text{Acidity loading lb/day}}{60 \text{ lb/ac/day}} \right] = \text{Minimum Wetland Size (acres)}$$

Based on the above calculations the first discharge averaging 723.04 gpm would require a minimum of 2.13 acres to effectively reduce the metals. The second discharge averaging 84.47 gpm would require 0.36 acres for treatment. Finally, the third discharge averaging 20.19 gpm would require a 0.26 acre wetland for treatment. These wetlands should maintain a water depth of 6 to 18 inches and include plants such as cattails, rushes, and reeds to slow the flow. In conclusion, the District feels that landowner permission to install such passive treatment technology is attainable.

#### References

- Applied Hydrogeology. C. W. Fetter. Prentice-Hall, Incorporated 1994.
- A Citizen's Handbook to Address Contaminated Coal Mine Drainage. US Environmental Protection Agency. EPA-903-K-97-003. September 1997.
- Partial Correlation Analysis of Some Chemical and Biological Parameters of Two Streams Receiving Mine Drainage. Fred Bremner, Richard Shertzer, Scott Corbett, and Jerry Centofani. 1977.
- Pennsylvania Code Title 25, Chapter 93. Department of Environmental Protection, Bureau of Watershed Conservation. March 22, 1997.
- The Science of Acid Mine Drainage and Passive Treatment. PA Department of Environmental Protection, Bureau of Abandoned Mine Reclamation. August 1999.

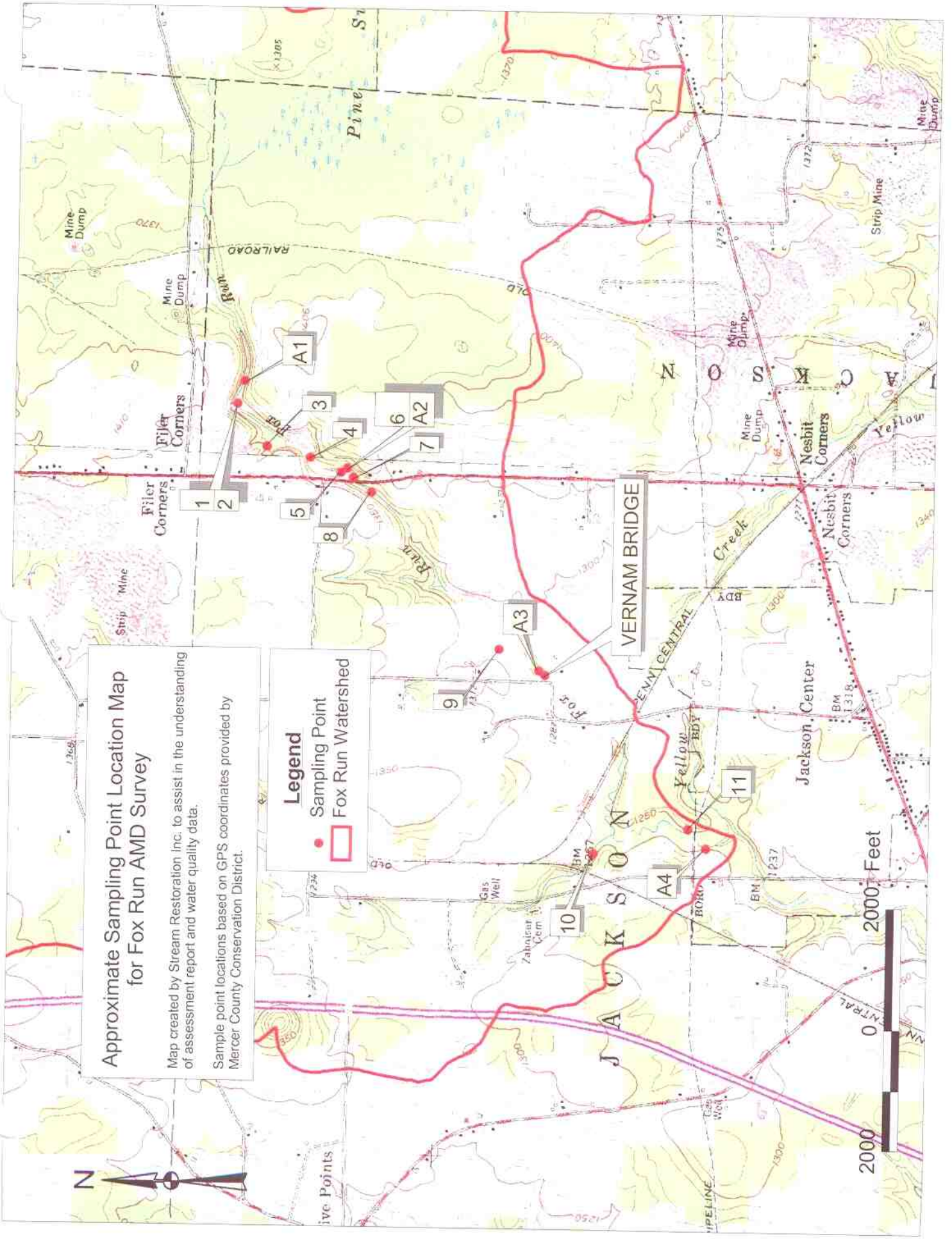
# Approximate Sampling Point Location Map for Fox Run AMD Survey

Map created by Stream Restoration Inc. to assist in the understanding of assessment report and water quality data.

Sample point locations based on GPS coordinates provided by Mercer County Conservation District.

## Legend

- Sampling Point
- Fox Run Watershed



## Location: 1

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	389.10	7.60	7.89	549.00	0.90	124.99	0.00	0.42	0.27	0.02	81.60	5.00	376.00
1/28/2000	229.30												
1/31/2000	178.20	6.93	6.76	213.00	0.10	13.40	0.00	0.12	0.03	0.10	56.10	13.00	149.00
2/16/2000	4097.10												
2/28/2000	4434.60	7.30	6.60	130.00	3.70	8.75	1.83	0.19	0.12	0.12	45.60	5.00	91.00
3/13/2000	2218.90	7.25	7.00	159.00	3.90	11.32	0.00	0.11	0.06	0.11	36.00	2.00	113.00
3/27/2000	1523.07												
4/25/2000	935.20	7.28	7.05	128.00	13.40	16.70	0.00	0.52	0.03	0.12	26.00	4.00	90.00
4/28/2000	472.28												
5/25/2000	2521.27	6.94	6.94	115.00	14.70	20.82	3.49	1.20	0.08	0.23	26.60	11.00	81.00
5/30/2000	657.88												
6/20/2000	1252.02												
6/28/2000	2450.96	6.92	7.05	132.00	18.70	30.34	0.00	2.20	0.25	0.21	25.80	10.00	92.00
7/25/2000	0.00												
7/31/2000	0.00												
8/24/2000	87.50												
8/28/2000	0.00												
9/6/2000	0.00												
<b>AVERAGE</b>	1191.52	7.22	7.04	203.71	7.91	32.33	0.76	0.68	0.12	0.13	42.53	7.14	141.71
<b>STANDARD</b>													
<b>DEVIATION</b>	1411.00	0.26	0.41	155.72	7.49	41.48	1.38	0.77	0.10	0.07	20.69	4.14	105.81

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 2

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	554.70	6.39	6.61	773.00	9.60	234.92	0.00	9.05	0.76	0.02	200.90	6.00	553.00
1/28/2000	320.40												
1/31/2000	556.06	6.28	6.77	782.00	9.80	242.78	0.00	10.25	0.75	0.02	211.40	9.00	547.00
2/16/2000	433.29												
2/28/2000	556.06	6.36	6.83	757.00	9.60	234.78	0.00	5.90	0.77	0.02	220.40	8.00	530.00
3/13/2000	660.65	6.63	6.68	769.00	9.70	227.96	0.00	5.86	0.74	0.02	194.30	5.00	537.00
3/27/2000	770.42												
4/25/2000	1190.06	6.33	6.56	768.00	10.10	211.11	0.00	5.34	0.67	0.02	221.50	7.00	538.00
4/28/2000	1286.32												
5/25/2000	884.96	6.38	6.61	761.00	10.10	225.71	0.00	5.75	0.70	0.02	237.30	6.00	533.00
5/30/2000	943.91												
6/20/2000	884.96												
6/28/2000	973.79	6.33	6.62	761.00	10.10	231.43	0.00	5.42	0.71	0.02	254.70	9.00	533.00
7/25/2000	770.42												
7/31/2000	660.65	6.27	6.61	760.00	9.90	235.28	0.00	5.92	0.71	0.02	235.70	4.00	532.00
8/24/2000	556.06												
8/28/2000	530.77	6.42	6.50	783.00	10.20	243.24	0.00	6.18	0.74	0.02	205.40	4.00	549.00
9/6/2000	481.23												
<b>AVERAGE</b>	723.04	6.38	6.64	768.22	9.90	231.91	0.00	6.63	0.73	0.02	220.18	6.44	539.11
<b>STANDARD</b>													
<b>DEVIATION</b>	261.81	0.10	0.10	9.00	0.22	9.20	0.00	1.66	0.03	0.00	18.45	1.83	7.94

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 3

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	89.8	7.02	7.51	500.00	0.00	66.19	0.00	0.13	<0.02	0.08	57.70	2.00	354.00
1/28/2000													
1/31/2000	1.12	6.69	7.45	583.00	0.30	91.73	0.00	6.15	0.05	0.05	56.70	10.00	408.00
2/16/2000	130.44												
2/28/2000	164.03	7.13	7.16	430.00	5.50	31.65	0.00	0.08	0.02	0.11	69.50	3.00	302.00
3/13/2000	71.3	7.56	7.39	520.00	4.80	41.27	0.00	0.17	0.05	0.11	59.80	2.00	365.00
3/27/2000	25.32												
4/25/2000	25.32	7.83	7.72	456.00	15.50	68.17	0.00	0.10	0.03	0.14	59.30	4.00	320.00
4/28/2000	16.46												
5/25/2000	71.3	7.30	7.47	418.00	14.20	64.15	0.00	0.10	0.03	0.02	75.50	2.00	292.00
5/30/2000	25.32												
6/20/2000	35.34												
6/28/2000	71.3	7.32	7.50	378.00	17.60	87.43	0.00	0.20	0.12	0.13	39.10	4.00	264.00
7/25/2000	0												
7/31/2000	0												
8/24/2000	0.01												
8/28/2000	0.01	7.22	7.33	584.00	19.20	111.04	0.00	0.08	0.14	0.04	38.70	2.00	410.00
9/6/2000	0												
<b>AVERAGE</b>	42.77	7.26	7.44	483.63	9.64	70.20	0.00	0.88	0.06	0.09	57.04	3.63	339.38
<b>STANDARD</b>													
<b>DEVIATION</b>	49.74	0.34	0.16	76.20	7.84	26.21	0.00	2.13	0.05	0.04	12.91	2.72	53.81

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

**Location: 4**

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	71.80	6.43	6.59	751.00	10.30	213.24	0.00	7.50	1.33	0.02	201.60	6.00	534.00
1/28/2000	71.98												
1/31/2000	96.62	6.38	6.77	739.00	10.40	207.96	0.00	7.03	1.27	0.02	233.70	8.00	517.00
2/16/2000	66.48												
2/28/2000	96.62	6.27	6.73	686.00	10.30	189.59	0.00	6.02	1.14	0.02	206.70	13.00	481.00
3/13/2000	96.62	6.46	6.66	681.00	10.50	189.27	0.00	6.19	1.18	0.02	175.70	5.00	476.00
3/27/2000	71.98												
4/25/2000	159.57	6.36	6.60	736.00	11.30	186.54	0.00	6.27	1.02	0.09	209.90	5.00	515.00
4/28/2000	96.62												
5/25/2000	83.76	6.41	6.66	842.00	10.50	232.12	0.00	7.09	1.34	0.02	307.30	5.00	590.00
5/30/2000	125.74												
6/20/2000	77.73												
6/28/2000	61.25	6.36	6.65	744.00	10.70	206.48	0.00	6.25	1.18	0.02	304.40	1.00	521.00
7/25/2000	66.48												
7/31/2000	71.98	6.34	6.65	802.00	10.70	221.01	0.00	6.74	1.29	0.02	231.20	5.00	561.00
8/24/2000	71.98												
8/28/2000	71.98	6.49	6.58	778.00	10.60	225.50	0.00	6.76	1.32	0.02	241.80	5.00	544.00
9/6/2000	61.25												
<b>AVERAGE</b>	84.47	6.39	6.65	751.00	10.59	207.97	0.00	6.65	1.23	0.03	234.70	5.89	526.56
<b>STANDARD</b>													
<b>DEVIATION</b>	25.02	0.07	0.06	51.42	0.31	16.72	0.00	0.50	0.11	0.02	44.96	3.22	36.16

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r



## Location: 5

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	0.22	6.71	7.02	891.00	0.30	117.06	0.00	14.50	1.85	1.12	26.30	4.00	633.00
1/28/2000	2.25												
1/31/2000	0.40	6.64	7.09	1016.00	0.30	127.50	0.00	8.45	1.06	0.42	73.90	10.00	711.00
2/16/2000	2.25												
2/28/2000	2.25	6.85	7.36	1434.00	4.80	105.22	0.00	0.83	0.23	0.04	241.40	7.00	1005.00
3/13/2000	2.25	7.40	7.29	1307.00	5.10	89.19	0.00	1.36	0.23	0.02	23.70	5.00	915.00
3/27/2000	2.25												
4/25/2000	0.40	7.05	7.15	1447.00	10.90	117.97	0.00	4.78	0.81	0.14	297.70	6.00	1013.00
4/28/2000	0.40												
5/25/2000	1.10	7.12	7.40	1454.00	14.50	142.30	0.00	2.40	0.52	0.02	254.20	5.00	1019.00
5/30/2000	0.40												
6/20/2000	0.00												
6/28/2000	1.10	7.17	7.42	1116.00	17.50	163.67	0.00	2.46	0.57	0.02	13.60	10.00	781.00
7/25/2000	0.00												
7/31/2000	0.00												
8/24/2000	0.01												
8/28/2000	0.00												
9/6/2000	0.00												
<b>AVERAGE</b>	0.85	6.99	7.25	1237.86	7.63	123.27	0.00	4.97	0.75	0.25	132.97	6.71	868.14
<b>STANDARD</b>													
<b>DEVIATION</b>	0.95	0.27	0.16	230.25	6.80	24.38	0.00	4.93	0.57	0.41	125.60	2.43	159.29

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 6

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	975.70	7.00	7.37	594.00	4.50	140.78	0.00	6.93	0.55	0.12	107.20	5.00	411.00
1/28/2000	933.00												
1/31/2000	903.90	6.94	7.55	689.00	6.10	193.79	0.00	4.70	0.66	0.02	191.60	14.00	482.00
2/16/2000	4216.90												
2/28/2000	6680.40	6.85	6.94	242.00	4.00	34.91	0.00	0.89	0.21	0.15	64.30	5.00	169.00
3/13/2000	3108.80	7.13	7.19	408.00	5.90	81.57	0.00	4.76	0.39	0.19	86.70	5.00	287.00
3/27/2000	2040.74												
4/25/2000	2409.50	7.02	7.14	563.00	11.10	136.79	0.00	2.63	0.47	0.02	151.50	7.00	394.00
4/28/2000	2175.79												
5/25/2000	4712.30	6.91	7.11	350.00	13.10	80.12	0.00	2.08	0.27	0.11	98.20	14.00	245.00
5/30/2000	1284.67												
6/20/2000	3200.3												
6/28/2000	4373.77	6.93	7.05	305.00	16.20	79.79	0.00	2.75	0.37	0.17	62.60	6.00	214.00
7/25/2000	1185.48												
7/31/2000	900.33	7.31	7.53	738.00	12.10	215.63	0.00	2.26	0.69	0.02	226.60	4.00	517.00
8/24/2000	985.48												
8/28/2000	741.60	7.58	7.54	738.00	12.90	227.72	0.00	2.17	0.70	0.02	207.30	4.00	517.00
9/6/2000	792.35												
<b>AVERAGE</b>	2312.28	7.07	7.27	514.11	9.54	132.34	0.00	3.24	0.48	0.09	132.89	7.11	359.56
<b>STANDARD</b>													
<b>DEVIATION</b>	1728.17	0.23	0.23	192.22	4.45	68.43	0.00	1.86	0.18	0.07	63.00	4.01	134.30

Notes: A value of 0 in the Acidity column indicates Not Detectable

A value of .02 in the Aluminum column indicates a value less than .04 mg/l

## Location: 7

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	12.60	6.64	6.80	913.00	9.00	252.55	0.00	10.75	1.67	0.02	307.20	7.00	674.00
1/28/2000	19.55												
1/31/2000	12.72	6.62	6.90	916.00	9.20	247.88	0.00	1.51	1.68	0.02	294.10	20.00	641.00
2/16/2000	12.72												
2/28/2000	22.23	6.45	6.89	1012.00	8.50	250.00	0.00	10.40	1.68	0.02	408.30	25.00	707.00
3/13/2000	12.72	6.86	6.79	920.00	9.80	245.39	0.00	9.75	1.59	0.02	313.30	6.00	643.00
3/27/2000	12.72												
4/25/2000	12.72	6.46	6.66	1108.00	10.40	272.30	0.00	16.25	1.81	0.02	417.40	7.00	776.00
4/28/2000	17.08												
5/25/2000	22.23	6.30	6.64	1473.00	11.10	326.03	0.00	23.05	2.34	0.02	795.80	21.00	1031.00
5/30/2000	22.23												
6/20/2000	22.23												
6/28/2000	12.72	6.20	6.45	1476.00	11.00	325.30	0.00	26.60	2.53	0.02	926.20	16.00	1034.00
7/25/2000	35.06												
7/31/2000	51.55	6.28	6.55	1356.00	11.30	333.57	0.00	20.30	2.25	0.02	530.90	6.00	950.00
8/24/2000	28.21												
8/28/2000	17.08	6.47	6.57	1080.00	11.00	284.99	0.00	17.40	1.94	0.02	428.10	8.00	756.00
9/6/2000	17.08												
<b>AVERAGE</b>	20.19	6.48	6.69	1139.33	10.14	282.00	0.00	15.11	1.94	0.02	491.26	12.89	801.33
<b>STANDARD</b>													
<b>DEVIATION</b>	10.02	0.21	0.16	234.93	1.05	37.03	0.00	7.77	0.34	0.00	224.79	7.59	161.08

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 8

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	0.45	6.47	6.40	761.00	0.60	55.83	0.00	23.80	1.35	2.27	92.60	6.00	533.00
1/28/2000	0.00												
1/31/2000	0.00	6.53	6.54	788.00	0.90	54.95	0.00	11.75	1.88	0.12	133.50	30.00	552.00
2/16/2000	0.40												
2/28/2000	0.07	6.19	6.58	825.00	7.00	57.27	0.00	18.20	1.28	0.06	149.30	33.00	578.00
3/13/2000	0.07	6.67	6.46	865.00	3.20	44.94	0.00	24.55	1.24	2.89	126.60	6.00	606.00
3/27/2000	0.07												
4/25/2000	0.00												
4/28/2000	0.00												
5/25/2000	0.00												
5/30/2000	0.40												
6/20/2000	0.07												
6/28/2000	0.19	6.40	6.58	803.00	15.80	93.03	0.00	17.25	1.17	0.09	95.60	4.00	562.00
7/25/2000	0.07												
7/31/2000	0.01	6.33	6.42	847.00	18.70	64.95	0.00	22.55	1.18	0.14	101.60	10.00	593.00
8/24/2000	0.07												
8/28/2000	0.07	6.50	6.50	872.00	17.00	110.42	0.00	27.90	1.53	1.46	90.50	32.00	611.00
9/6/2000	0.00												
<b>AVERAGE</b>	0.11	6.44	6.50	823.00	9.03	68.77	0.00	20.86	1.38	1.00	112.81	17.29	576.43
<b>STANDARD</b>													
<b>DEVIATION</b>	0.15	0.15	0.07	41.26	7.94	23.79	0.00	5.44	0.25	1.20	23.37	13.60	28.98

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 9

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	809.60	7.37	7.88	580.00	3.70	141.37	0.00	0.79	0.38	0.02	77.00	4.00	411.00
1/28/2000	810.12												
1/31/2000	810.12	7.73	8.05	721.00	4.20	188.32	0.00	0.38	0.56	0.04	174.30	15.00	504.00
2/16/2000	3543.99												
2/28/2000	6399.57	6.00	7.08	226.00	3.90	32.53	0.00	0.62	0.19	0.09	60.50	6.00	159.00
3/13/2000	2719.84	6.94	7.56	401.00	4.20	82.51	0.00	1.15	0.29	0.02	117.90	4.00	281.00
3/27/2000	1869.56												
4/25/2000	2281.76	7.56	7.64	556.00	10.40	137.31	0.00	1.97	0.42	0.02	137.90	6.00	389.00
4/28/2000	1869.56												
5/25/2000	3182.16	7.38	7.49	346.00	13.10	81.02	0.00	2.21	0.27	0.18	82.90	5.00	242.00
5/30/2000	2072.32												
6/20/2000	2388.93												
6/28/2000	3918.17	7.26	7.37	312.00	16.10	79.84	0.00	2.53	0.34	0.13	63.50	4.00	218.00
7/25/2000	810.12												
7/31/2000	810.12	7.99	8.09	722.00	12.90	220.04	0.00	1.19	0.54	0.02	231.20	5.00	506.00
8/24/2000	810.12												
8/28/2000	735.56	8.24	8.10	758.00	12.70	226.05	0.00	0.82	0.51	0.02	216.60	4.00	531.00
9/6/2000	526.74												
<b>AVERAGE</b>	2020.46	7.39	7.70	513.56	9.02	132.11	0.00	1.30	0.39	0.06	129.09	5.89	360.11
<b>STANDARD</b>													
<b>DEVIATION</b>	1531.30	0.65	0.36	198.91	4.98	68.51	0.00	0.76	0.13	0.06	65.37	3.52	139.40

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 10

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	248.60	7.64	7.67	321.00	0.40	72.51	0.00	0.17	0.04	0.08	22.90	2.00	219.00
1/28/2000	107.26												
1/31/2000	196.49	7.82	7.77	323.00	0.20	83.38	0.00	0.27	0.05	0.04	59.30	10.00	226.00
2/16/2000	1439.62												
2/28/2000	1626.74	6.76	7.36	227.00	4.20	34.30	0.00	0.16	0.02	0.13	36.80	5.00	160.00
3/13/2000	1003.85	7.91	7.64	295.00	1.60	47.41	0.00	0.15	0.03	0.02	46.70	3.00	207.00
3/27/2000	484.35												
4/25/2000	484.35	7.97	7.81	266.00	9.60	62.44	0.00	0.17	0.03	0.02	41.70	4.00	187.00
4/28/2000	274.03												
5/25/2000	766.92	7.54	7.66	224.00	13.80	57.60	0.00	0.35	0.03	0.20	26.90	4.00	157.00
5/30/2000	149.69												
6/20/2000	420.42												
6/28/2000	1003.85	7.50	7.51	195.00	17.40	54.95	0.00	0.47	0.04	0.26	16.40	2.00	137.00
7/25/2000	0.00												
7/31/2000	53.11	7.65	7.67	317.00	18.50	100.91	0.00	0.26	0.10	0.02	25.40	2.00	222.00
8/24/2000	69.76												
8/28/2000	38.03	7.77	7.63	330.00	16.80	104.73	0.00	0.27	0.15	0.02	30.80	2.00	231.00
9/6/2000	24.72												
<b>AVERAGE</b>	466.21	7.62	7.64	277.56	9.17	68.69	0.00	0.25	0.05	0.09	34.10	3.78	194.00
<b>STANDARD</b>													
<b>DEVIATION</b>	501.48	0.36	0.13	51.16	7.70	23.86	0.00	0.11	0.04	0.09	13.40	2.59	34.99

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: 11

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	1441.50	7.65	7.89	453.00	0.00	108.15	0.00	0.33	0.18	0.05	74.60	3.00	327.00
1/28/2000	2147.00												
1/31/2000	2200.90	7.90	7.99	547.00	0.00	136.47	0.00	0.27	0.28	0.10	123.60	11.00	383.00
2/16/2000	7479.20												
2/28/2000	13328.00	6.43	7.38	225.00	4.30	32.48	0.00	0.44	0.11	0.11	56.80	5.00	158.00
3/13/2000	4354.20	8.26	7.82	358.00	2.30	65.23	0.00	0.75	0.22	0.08	79.90	3.00	251.00
3/27/2000	4170.85												
4/25/2000	3706.90	8.15	8.02	438.00	9.70	107.61	0.00	0.63	0.19	0.02	120.40	5.00	307.00
4/28/2000	3114.86												
5/25/2000	7012.50	7.50	7.70	281.00	14.00	65.04	0.00	1.16	0.14	0.14	65.00	5.00	197.00
5/30/2000	3090.06												
6/20/2000	4521.09												
6/28/2000	10515.53	7.40	7.47	240.00	17.10	60.91	0.00	1.57	0.20	0.22	38.30	2.00	169.00
7/25/2000	1516.96												
7/31/2000	1704.78	8.00	8.15	655.00	18.40	186.78	0.00	0.60	0.30	0.05	185.40	3.00	459.00
8/24/2000	1407.15												
8/28/2000	1012.50	8.16	8.06	634.00	16.20	191.61	0.00	0.52	0.20	0.02	173.40	3.00	443.00
9/6/2000	897.26												
<b>AVERAGE</b>	4090.07	7.72	7.83	425.67	9.11	106.03	0.00	0.70	0.20	0.09	101.93	4.44	299.33
<b>STANDARD</b>													
<b>DEVIATION</b>	3451.74	0.57	0.27	162.74	7.58	56.53	0.00	0.42	0.06	0.06	51.92	2.70	113.87

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r

## Location: Vernam Bridge

Date	Discharge	pH		Conductivity (umhos/cm)	Temperature Celcius	Alkalinity (mg/L CaCO3)	Acidity (mg/L CaCO3)	Total Iron (mg/L)	Manganese (mg/L)	Aluminum (mg/L)	Sulfate (mg/L SO4 -2)	Suspended Solids (mg/L)	TDS (mg/L)
		Field	Lab										
12/29/1999	850.00	7.60	7.89	549.00	0.90	124.99	0.00	0.42	0.27	0.02	81.60	5.00	376.00
1/28/2000	1438.00												
1/31/2000	1441.10	8.18	8.15	651.00	2.20	178.05	0.00	0.13	0.35	0.04	152.00	10.00	456.00
2/16/2000	4780.20												
2/28/2000	8424.40	6.55	7.33	228.00	3.90	32.82	0.00	0.54	0.15	0.09	62.50	4.00	161.00
3/13/2000	3639.30	7.79	7.80	369.00	3.20	78.42	0.00	0.60	0.22	0.02	102.80	2.00	258.00
3/27/2000	2822.63												
4/25/2000	2810.60	8.00	7.97	529.00	9.60	131.83	0.00	1.21	0.33	0.02	134.10	6.00	370.00
4/28/2000	2237.03												
5/25/2000	3281.40	7.70	7.73	314.00	13.20	77.26	0.00	1.94	0.21	0.14	60.40	4.00	220.00
5/30/2000	2255.68												
6/20/2000	2814.64												
6/28/2000	4860.49	7.60	7.63	298.00	16.20	77.46	0.00	2.28	0.28	0.12	58.30	2.00	208.00
7/25/2000	1220.56												
7/31/2000	1129.06	8.19	8.24	708.00	14.30	207.69	0.00	0.44	0.26	0.02	203.70	3.00	496.00
8/24/2000	962.97												
8/28/2000	903.40	8.37	8.20	705.00	13.70	203.69	0.00	0.21	0.19	0.02	194.90	2.00	493.00
9/6/2000	842.05												
<b>AVERAGE</b>	2595.20	7.78	7.88	483.44	8.58	123.58	0.00	0.86	0.25	0.05	116.70	4.22	337.56
<b>STANDARD</b>													
<b>DEVIATION</b>	1943.19	0.54	0.30	185.54	6.02	62.33	0.00	0.77	0.07	0.05	57.20	2.59	129.39

Notes: A value of 0 in the Acidity column indicates Not Detecta

A value of .02 in the Aluminum column indicates a value less than .04 r



## Cumulative Macroinvertebrate Index Totals for Fox Run

### Location: A-1

Date	Index Value
2/24/2000	13
5/31/2000	13
7/20/2000	
8/31/2000	
9/8/2000	
9/11/2000	

Average            13  
Standard  
Deviation            0

### Location: A-2

Date	Index Value
2/24/2000	9
5/31/2000	14
7/20/2000	11
8/31/2000	8
9/8/2000	9
9/11/2000	8

Average            9.83  
Standard  
Deviation            2.32

NOTE: sampling location A-1 had insufficient flow to perform sampling or was completely dry on these sampling dates

### Location: A-3

Date	Index Value
2/24/2000	19
5/31/2000	20
7/20/2000	22
8/31/2000	17
9/8/2000	18
9/11/2000	20

Average            19.33  
Standard  
Deviation            1.75

### Location: A-4

Date	Index Value
2/24/2000	13
5/31/2000	21
7/20/2000	20
8/31/2000	18
9/8/2000	20
9/11/2000	23

Average            19.17  
Standard  
Deviation            3.43