SURFACE WATER HYDROLOGY

The surface water hydrology of the site has been logically divided into six phases of monitoring, analyses, and investigation as outlined below:

Sample Station Locations and
Descriptions Definition of Flow
Systems
Establishment of Continuous Flow Recording
Station Comparison of Specific Discharge Yield
Relationships Physical and Chemical Analysis
of Surface Water Data Results of Daily
Loadings Modeling Study Summary of Surface
Water Impact Assessment

The reviewer will be asked to refer to selected maps and appendices which accompany this report throughout this section.

1. Sample Station Locations and Descriptions

Eight surface water sampling stations were developed to serve as monitoring points. Each surface water sampling station was monitored weekly measuring:

- discharge (cfs)
- specific conductance
- field pH
- laboratory pH
- alkalinity (mg/ l - 4.5 pH)
- acidity (mg/l - 8.2 pH)
- sulphates (mg/l)
- total iron (mg/l)
- ferrous iron (mg/l)

The general location of each surface water sample station is shown on Sheet 2 of the plans - General Location Map. Additionally, each sample station has an accompanying reference map showing the mean tendencies, the seasonal variation (expressed at 95% confidence level as variance field for all measured parameters) and correlation relationships of the physical and chemical parameters monitored and an accompanying appendix containing a site map, summary of physical and chemical relationships observed, listing of data collected during monitoring, and statistical analysis sheets.

Sample Station	Map Reference	Appendix	Location
1	18	1	Slippery Rock Creek
2	17	2	Tributary to Slippery Rock Creek
3	15	3	Slippery Rock Creek
4	14	4	Big Bertha Artesian Well Discharge
5	16	5	Surface Mine Pit Discharge
6	13	6	Tributary to Slippery Rock Creek
7	11	7	Slippery Rock Creek
8	12	8	Deep Mine Outcrop Seepage

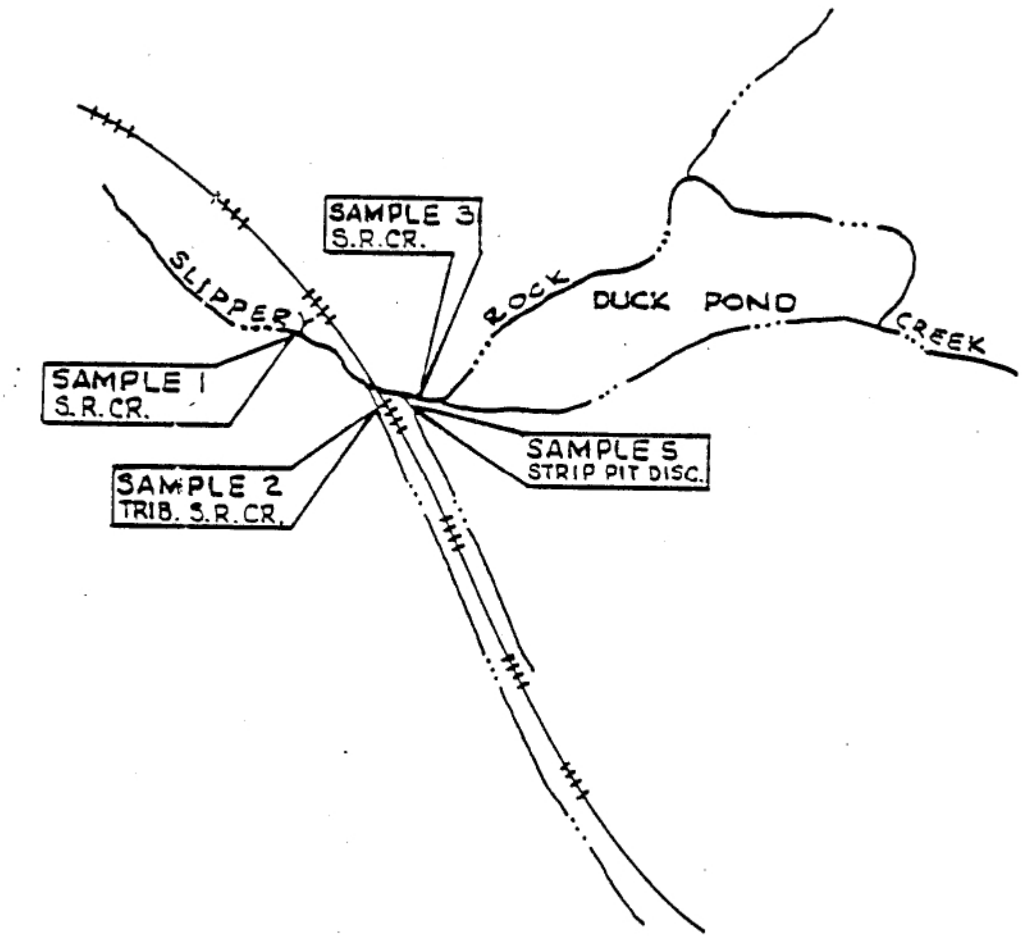
CONSERVATION OF MASS RELATIONSHIP * - FLOW SYSTEM 1

DATE SAMPLED	STATION 6	STATION 8	STATION 7	STATION 4		STATION 3 (inferred)	STATION 3 (measured)	DIFFER.
2/17/83	1.62	.02	7.41	.04		9.09	8.76	.33
2/28/83	1.36	.02	5.33	.04		6.75	6.98	-.23
3/7/83	1.11	.01	4.56	.04		5.72	5.72	
3/14/83	1.62	.02	6.55	.04		8.23	8.33	-.10
3/25/83	3.13	.03	12.65	.04		15.85	15.79	.06
3/31/83	3.13	.03	12.65	.04		15.85	15.79	.06
4/7/83	3.74	.03	13.73	.04		17.54	17.54	--
4/13/83	4.93	.04	18.28	.04		23.29	23.26	.03
4/20/83	3.74	.04	13.73	.04		17.55	17.54	.01
4/26/83	1.90	.03	7.85	.04		9.82	9.65	.17
5/4/83	6.98	.07	26.34	-		33.39	33.61	-.22
5/11/83	2.48	.03	9.70	-		12.21	12.54	-.33
5/19/83	2.48	.03	9.24	-		11.75	11.80	-.05
5/25/83	5.72	.04	20.47	-		26.23	26.22	.01
6/1/83	2.19	.03	9.70	-		11.92	11.80	.12
6/7/83	2.73	.03	10.18	-		12.94	12.88	.06
6/12/83	0.48	.02	6.13	.08		6.71	6.64	.07
6/16/83	0.48	.02	4.93	.04		5.47	5.72	-.25
6/21/83	0.30	.02	4.93	.04		5.29	5.33	-.04
6/29/83	6.13	.05	21.03	.04		27.25	27.18	.07
7/10/83	0.18	.02	3.47	.04		3.71	3.82	-.11
7/19/83	0.18	.02	3.13	.04		3.37	3.47	-.10
7/26/83	0.08	.01	1.90	.04		2.03	2.19	-.16
8/6/83	0.08	.01	1.62	.04		1.75	1.90	-.15
8/21/83	0.02	.01	1.36	.04		1.43	1.38	.05

* All values expressed as c.f.s.

Flow System Two

Flow system two is defined as monitoring all the drainage emanating from the watershed area beginning above the trestle station where the continuous recording flow monitoring device (bubbler) was installed and extending below the trestle station. This includes the aggregate discharges of sample stations 3, 5, 2, and 1. A schematic of the relationship of this flow system is shown below:



As shown in the schematic above, all of the discharges below the duck pond make up this flow system. We confirmed the conservation of mass relationship between the upstream and downstream points and the points contributing, flow between. The following page shows the essential comparisons.

3. Establishment of Continuous Flow Recording Station

A Sigma-Motor bubbler was established to allow "instantaneous" stage and discharge measurements at the site, for a 6-month period.

The bubbler was placed in a locked steel box and chained securely to several trees. The steel box was placed in a concealed area in an attempt to minimize the potential for vandalism.

The bubbler tube was routed along the ground to the trestle base immediately beyond sample station 3, and was fastened to a secure staff gauge which was set in the stream.

The bubbler was outfitted with heavy duty 12 V.D.C. batteries which would permit accurate operation up to 15 days during reasonable weather. These batteries were switched weekly and recharged for later use.

The bubbler was located at Station 3 as this station is the only point common to both flow systems as previously described.

The relationship of stream stages at the weirs and the stream stage at the bubbler staff gauge are shown on the following sheets:

Flow System 1 - Sheet 32
Flow System 2 - Sheet 33

The reviewer will note that the calculated ideal discharge curve for the bubbler at Station 3 was checked by current meter measurements. Also, note that station 3 is the common station for each flow system and is therefore shown on both sheets.

The relationships between the measured discharges at the other sampling stations to the trestle station bubbler are given below:

Sample Station	Correlation Coefficient	(Bubbler vs. Sample Station)
1	.9952	(99.52%)
2	.9975	(99.75%)
5	.9672	(96.72%)
6	.9932	(99.32%)
7	.9992	(99.92%)
8	.9452	(99.52%)

The reviewer will also note that Station 4 is not correlated to the bubbler. This is because it was measured by its own bubbler (and acted as a steady-state discharge). Also, Station 3 was not correlated as the bubbler is simply repeating Station 3 measurements and this station was used for backup calibration purposes.

The statistical analysis of the correlation between the sample stations and the bubbler are contained in Appendix 22. The next page contains a sample output of the statistical analysis.

SAMPLE.ONE TRESTLE STATION DISCHARGE VS. SAMPLE

COEFFICIENT MATRIX AND AUGMENTED MATRIX

2	29	524.1200
29	527	9705.3113

REGRESSION COEFFICIENTS OF NORMAL EQUATION

\- 2.396545943850

1.974153760804

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
8.7600	14.6900	14.8970	0.2070
6.9800	10.2900	11.3830	1.0930
5.7200	8.3600	8.8956	0.5356
8.3300	13.8400	14.0482	0.2082
15.7900	28.7100	28.7753	0.0653
15.7900	28.2000	28.7753	0.5753
17.5400	29.?500	32.2301	2.2801
23.2600	49.9400	43.5223	6.4177
17 5400	31.0000	32.2301	1.2301
9.6500	15.??00	16.6540	0.6640
33.6100	63.6000	63.9548	0.3548
12.5400	21.5800	22.3593	0.7793
11.8000	19.9200	20.8985	0.9785
26.2200	48.8100	49.3658	0.5558
11.8000	18.5600	20.8985	2.3385
12.8800	22.3600	23.0306	0.6706
6.6400	10.6400	10.7118	0.0718
5.7200	8.3600	8.8956	0.5356
5.3300	7.9700	8.1257	0.1557
27.1800	51.8600	51.2610	0.5990
3.8200	6.1700	5.1447	1.0253
3.4700	5.5300	4.4538	1.0762
2.1900	3.2300	1.9269	1.3031
1.9000	2.7300	1.3543	1.3757
1.3800	1.8300	0.3278	1.5022

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
NUMBER OF X - Y PAIRS= 25
TOTAL SUMS OF SQUARE= 6982.521024
SUMS OF SQUARES DUE TO REGRESSION= 6915.628167
SUMS OF SQUARES DUE TO DEVIATION= 66.892857
GOODNESS OF FIT= .99042
MULTIPLE CORRELATION COEFFICIENT 0.99520
STANDARD DEVIATION 1.669492

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	6915.63	1	6915.63
DEVIATION	66.89	23	2.91
TOTAL VARIATION	6982.52	24	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
F TEST - SIGNIFICANCE OF REGRESSION = 2377.82
LEVEL .05% - CRITICAL VALUE = 4.28

4. Measurement of Stage Relationships Using Specific Discharge Yield Relationships

The specific discharge yield method is also very useful in determining the relationship of one watershed to another. The specific yield is generally expressed in one of three formats:

a. gallons/acre (of drainage area) b. c.f.s./1000 acres (of drainage area) c. c . f . s . /sq. mi. (of drainage area)

This author prefers format b. for watershed areas of the size encountered in this study. The purpose of developing specific discharge yield relationships is to allow an assessment of the discharge potential of a watershed. When several watersheds are situated in similar geologic, hydrologic, and topographic settings then the watersheds may be compared. Generally, for similar watershed settings described above, the specific discharge yield values will be similar. When comparing groups of watersheds, some watersheds may exhibit specific discharge yield values considerably less than average, while some may . exhibit markedly higher values. Generally, the following conclusions can be supported:

1. During baseflow, watersheds which exhibit high yield values are probably influenced by favorable discharge conditions such as underground mine discharges, well field discharges and flowing artesion wells, or reservoirs. Conversely, low yield values indicate unfavorable geologic settings such as being situated at the top of an anticline where there is little upgradient recharge area to support spring development or moderation of recharge by mine cap-hire or well field depletion.

2. During highflow, watersheds which exhibit high yield values may have additional sources such as urban runoff and diversion outflow. Low yield values indicate capture of runoff (reservoir storage), high infiltration tendencies (diversion into mine pools or spoil) or unfavorable geologic conditions (moderation by faults).

The following page shows specific discharge yields for the watersheds associated with the surface water sampling. This page should be read from right to left by rows where sample seven starts above the project area and sample one is the outflow.

Two watersheds are of interest in regard to their yields. The watershed for sample station five is nearly entirely mined. During low flow conditions, this watershed exhibits very high specific discharge yield values due to mine drainage and regional groundwater discharges. Conversely, during high flow conditions, this watershed exhibits very low yields due to runoff capture in the strip ponds and high infiltration tendencies (partial diversion into deep mine pool).

Sample station two exhibits very high yields during storm events (35 c.f.s./100 acres more than adjacent watersheds). This is believed to be caused by two factors, the small amount of mined area in this watershed in relation to the adjacent watersheds and urban runoff from Hilliards and Whiskerville.

-
7
/

6. Selection of Points for Loadings Modeling

In order to arrive at an impact assessment relative to any future abate rent work which might be undertaken; it is essential that we be able to describe the current relationship between the discharge in question and its immediate receiving stream .

This is accomplished by calculating the loadings of each member and expressing the percent or relative contribution of the discharge to the receiving stream.

The method of estimating the daily loadings is identical for each sample station, except sample station 4. The discharge for each sample station is calculated utilizing the regression equation for that station which can be related with a very high correlation to the continuous discharge recording station (trestle staff bubbler). Next, the most probable conductance can be selected utilizing the regression equation for conductance related to the discharge. In a similar fashion the alkalinity, acidity, sulphates, total iron, and ferrous iron parameters can be estimated utilizing the specific regression equation for each. Finally, the loadings for each parameter are calculated as the predicted concentration multiplied by the discharge. This is done hourly and the twenty-four loadings are sunned and averaged over the day. The rainfall data comes from the continuous recording rain gauge.

The daily loadings estimated for sample station four are derived differently. Unlike the other sample stations which have variable discharges, sample station four is a STEADY STATE DISCHARGE. Since the discharge doesn't vary, there was no good way to correlate the sample station to the continuous discharge recording station and estimate daily values accurately. Therefore, the pre-closure data was averaged for each parameter and utilized throughout.

One objective of this contract was to calculate the cumulative daily loadings. This has been done and the results shall be presented in two fashions:

a. Loadings Summary Sheets

The following four appendices (23, 24, 25, 26) show the accumulated daily loadings for the two discharges which are considered as being potential targets for abatement measures, that is:

(1) Sample Station 4 - Big Bertha Artesian Well
(2) Sample Station 5 - Surface Mine Pit Discharge

and, for the receiving streams below the discharges, that is:

(1) Sample Station 1 - Slippery Rock Creek (Below 5)
(2) Sample Station 3 - Slippery Rock Creek (Below 4)

The loadings summary sheets show the following information:

Discharge, average (cfs) daily
Rainfall, inches daily
Alkalinity, pounds daily
Acidity, pounds daily
Sulphates, pounds daily
Total Iron, pounds daily
Ferrous Iron, pounds daily

The following five pages summarize the system loadings comparisons between the flowing artesian well (station 4) and Slippery Rock Creek (station 3) downstream; and between the surface mine facility and washery discharge (station 5) and Slippery Rock Creek (station 1) downstream.

The reader will notice, when reviewing the appendices and comparing those values to the summary sheets on the following pages, that the minimum and maximum values DO NOT occur on the same days. Normally, in watersheds that are unrestricted, the minimum and -maximum values do occur on the same dates. However, in watersheds that have impoundments with reservoirs; the minimum and maximum values may not occur on the same day. There are two :sic mechanisms which explain why this is the case.

1. Time of Travel

The reservoir has a volume of storage which will significantly modify the hydrograph of stream s) (during an event) when comparing an upstream point(s) to a downstream point(s). There is usually a delay in the peak and the magnitude of the peak is reduced.

2. Mixing Effects

The chemical quality of the stream(s) above the impoundment will rarely be preserved. The mixing effect of the stream(s) and the impoundment will modify the resultant chemical quality of the outflow. If the stream(s) quality is similar to that of the reservoir, then generally only dilution will occur and the resultant water will be a "composite" of the two. When the stream(s) quality is significantly different, then the chemical reactivity of the two waters must also be considered and the outflow from the reservoir may be significantly different from that of the stream(s) feeding the reservoir.

From the above discussion, it should be apparent that in some instances, a feeder stream entering the reservoir will have its peak loading anywhere from several hours to several days removed from the peak loading of the reservoir outflow. At this site, there are several significantly different discharges and streams all entering the duck pond reservoir. Further, when comparing peak chemical loadings for the reservoir outflow with downstream tributaries, the downstream tributaries may have reached peak chemical loadings several days before the peak loading period occurs for the reservoir outflow.

ALKALINITY SYSTEM LOADINGS COMPARISON SHEET

1. Relationship Between Sample 3 and Sample 4 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Flowing Well)	% Loading
4/83	Minimum	0.00	9.02	–
	Maximum	0.00	9.02	–
5/83	Minimum	0.00	9.02	–
	Maximum	0.00	9.02	–
6/83	Minimum	0.00	9.02	–
	Maximum	0.00	9.02	–
7/83	Minimum	0.00	9.02	–
	Maximum	0.00	9.02	–
8/83	Minimum	0.00	9.02	–
	Maximum	0.00	9.02	–
9/83	Minimum	0.00	9.02	–
	Maximum	0.00	9.02	–

2. Relationship Between Sample 1 and Sample 5 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Strip Pit)	% Loading
4/83	Minimum	0.00	0.00	–
	Maximum	0.00	0.00	–
5/83	Minimum	0.00	0.00	–
	Maximum	0.00	0.00	–
6/83	Minimum	0.00	0.00	–
	Maximum	0.00	0.00	–
7/83	Minimum	0.00	0.00	–
	Maximum	0.00	0.00	–
8/83	Minimum	0.00	0.00	–
	Maximum	0.00	0.00	–
9/83	Minimum	0.00	0.00	–
	Maximum	0.00	0.00	–

ACIDITY SYSTEM LOADINGS COMPARISON SHEET

1. Relationship Between Sample 3 and Sample 4 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Flowing Well)	% Loading
4/83	Minimum	983.14	52.86	5%
	Maximum	2501.37	52.86	2%
5/83	Minimum	984.62	52.86	5%
	Maximum	3575.35	52.86	1%
6/83	Minimum	358.12	52.86	15%
	Maximum	2902.47	52.86	2%
7/83	Minimum	211.26	52.86	25%
	Maximum	1309.42	52.86	4%
8/83	Minimum	238.94	52.86	22%
	Maximum	1264.05	52.86	4%
9/83	Minimum	288.64	52.86	18%
	Maximum	2040.70	52.86	3%

2. Relationship Between Sample 1 and Sample 5 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Strip Pit)	% Loading
4/83	Minimum	2019.33	405.62	20%
	Maximum	4662.02	1121.43	24%
5/83	Minimum	2020.89	511.03	25%
	Maximum	6566.18	3335.02	51%
6/83	Minimum	1301.14	452.90	35%
	Maximum	5547.30	4676.68	84%
7/83	Minimum	252.15	455.42	-
	Maximum	2741.53	570.83	21%
8/83	Minimum	74.85	456.17	-
	Maximum	2654.03	908.64	34%
9/83	Minimum	135.18	457.62	-
	Maximum	4182.34	911.41	22%

SULPHATES SYSTEM LOADINGS COMPARISON SHEET

1. Relationship Between Sample 3 and Sample 4

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Flowing Well)	% Loading
4/83	Minimum	5846.71	228.97	4%
	Maximum	12313.38	228.97	2%
5/83	Minimum	6038.02	228.97	4%
	Maximum	16766.43	228.97	1%
6/83	Minimum	2395.59	228.97	10%
	Maximum	14140.14	228.97	2%
7/83	Minimum	1496.21	228.97	15%
	Maximum	7364.14	228.97	3%
8/83	Minimum	1687.93	228.97	13%
	Maximum	7123.14	228.97	3%
9/83	Minimum	2028.29	228.97	11%
	Maximum	10665.24	228.97	2%

2. Relationship Between Sample 1 and Sample 5

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Strip Pit)	% Loading
4/83	Minimum	9976.95	995.27	10%
	Maximum	24525.84	2281.66	9%
5/83	Minimum	9986.70	995.81	10%
	Maximum	35027.20	7006.95	20%
6/83	Minimum	1471.03	857.67	58%
	Maximum	29166.42	9119.40	31%
7/83	Minimum	1178.61	844.16	72%
	Maximum	13747.64	1138.64	8%
8/83	Minimum	348.67	846.21	-
	Maximum	13254.56	1682.38	13%
9/83	Minimum	631.86	850.19	-
	Maximum	21436.06	1800.91	8%

TOTAL IRON SYSTEM LOADINGS COMPARISON SHEET

1. Relationship Between Sample 3 and Sample 4 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Flowing Well)	% Loading
4/83	Minimum	72.54	33.21	46%
	Maximum	149.29	33.21	22%
5/83	Minimum	72.61	33.21	46%
	Maximum	201.91	33.21	16%
6/83	Minimum	30.08	33.21	-
	Maximum	171.20	33.21	19%
7/83	Minimum	18.89	33.21	-
	Maximum	90.79	33.21	37%
8/83	Minimum	21.31	33.21	-
	Maximum	87.96	33.21	38%
9/83	Minimum	25.81	33.21	-
	Maximum	130.33	33.21	25%

2. Relationship Between Sample 1 and Sample 5 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Strip Pit)	% Loading
4/83	Minimum	160.52	75.73	47%
	Maximum	339.01	243.65	72%
5/83	Minimum	160.60	75.82	47%
	Maximum	467.24	258.80	55%
6/83	Minimum	24.29	51.61	-
	Maximum	403.74	230.52	57%
7/83	Minimum	6.20	49.21	-
	Maximum	213.64	95.85	45%
8/83	Minimum	6.40	49.58	-
	Maximum	208.17	97.41	47%
9/83	Minimum	11.51	50.28	-
	Maximum	316.11	145.79	46%

FERROUS IRON SYSTEM LOADINGS COMPARISON SHEET

1. Relationship Between Sample 3 and Sample 4 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Flowing Well)	% Loading
4/83	Minimum	33.05	31.72	97%
	Maximum	87.51	31.72	36%
5/83	Minimum	33.10	31.72	96%
	Maximum	126.20	31.72	25%
6/83	Minimum	11.68	31.72	-
	Maximum	101.74	31.72	31%
7/83	Minimum	6.78	31.72	-
	Maximum	44.58	31.72	71%
8/83	Minimum	7.68	31.72	-
	Maximum	42.44	31.72	75%
9/83	Minimum	9.37	31.72	-
	Maximum	70.57	31.72	45%

2. Relationship Between Sample 1 and Sample 5 (in pounds/day)

Month		Recieving Stream (Slippery Rock Creek)	Discharge (Strip Pit)	% Loading
4/83	Minimum	60.84	11.44	19%
	Maximum	178.21	59.26	33%
5/83	Minimum	60.94	11.47	19%
	Maximum	263.24	93.12	35%
6/83	Minimum	8.65	5.59	65%
	Maximum	211.63	92.70	44%
7/83	Minimum	1.63	5.01	-
	Maximum	87.73	16.02	18%
8/83	Minimum	1.72	5.10	-
	Maximum	83.32	9.76	12%
9/83	Minimum	3.16	5.26	-
	Maximum	145.55	23.52	16%

b. Loadings Hydrographs

While the loadings summary sheets meet the essential requirements of the contract, the author has prepared loading hydrographs to allow a second method of assessing the relationship of the loadings of the discharge in comparison to the receiving stream.

The loadings hydrographs are bound separately and are appropriately labelled. When reviewing the loadings hydrographs, be aware of the following:

(1) Technically, the loadings summary sheets are more accurate as they are calculated to the hundredth of a pound based on the observed physical and chemical relationships for each sample station; by accumulating the hourly values and obtaining a daily loading sum.

(2) However, the loadings hydrographs are more representative as they show the relationships on an HOURLY basis such that "events" can be more readily studied and their impact gauged. The drawback to the hourly loadings hydrographs is scalerelated (that is to make the scale sufficient to show the extremes necessitates choosing some minimum or threshold value for each incremental change when printed by the computer).

(3) Due to the size, the hydrographs are on file for review at the Office of Resources Management, Division of Mine Hazards and the reviewer is directed to contact them for inspection purposes.

SUMMARY OF SURFACE WATER IMPACT ASSESSMENT

Daily loadings values were calculated for the discharges at sample station 4 (Big Bertha artesian well), sample station 5 (surface mine reservoir discharge) and the downstream sample stations (sample stations 3 and 1).

The artesian well was determined to impact the downstream water quality at sample station 3 (discharge from duck pond immediately downstream from well) as described below:

1. The acidity contributed from the artesian well to the surface flow system ranges from 1 % to 25% of the total acidity loading in the downstream monitoring point.

2. The alkalinity contributed from the artesian well was fully reacted (as a neutralizing agent) as the surface. flow system downstream showed no alkalinity generally present.

3. The sulphates contributed from the artesian well to the surface flow system ranges from 1% to 15% of the total sulphate loading ing the downstream monitoring point.

4. The. total iron contributed from the artesian well to the surface flow system ranges from 19% to 46% of the total iron loading in the downstream monitoring point. During extremely low flow situations, the total. iron value was shown to exceed the value in the stream; however, this fails to account for the obvious deposition of flowculated iron at the duck pond. These precipitates are periodically flushed during high flow events.

5. The ferrous iron contributed from the artesian well to the surface flow system ranges from 45% to 96% of the ferrous iron loading in the downstream monitoring point. The change from ferrous iron to ferric iron which most likely occurs would indicate that the actual contribution may be somewhat lower. Additionally, the ferrous iron values during extremely low flow situations exceeded the values in the stream. Again, this fails to account for the obvious flocculates iron precipitates which are highly obvious at the duch pond, and the state change which is accompanied during this process.

The surface mine reprocessing operation was determined to have the following impact on the downstream water quality and loadings at downstream sample station 1 on Slippery Rock Creek approximately 200 feet below discharge outflow from surface mine reprocessing operation (sample station 5) as described below:

1. The acidity contributed from the surface mine reprocessing operation to the surface water flow system ranges from 21% to 84% of the total acidity loading in the downstream monitoring point. However, with the exception of very large events where "slugs" were introduced, the upper limit of acidity loadings never exceeded 35% of the downstream total loadings.

2. No alkalinity was observed from the surface mine reprocessing operation.

3. The sulphates contributed from the surface mine reprocessing operation to the surface water flow system ranged from 8% to 72% of the total sulphates in the downstream monitoring point. Again, with the exception of very large events (where slugs were introduced) the upper limit of sulphate loadings never exceeded 31%.

4. The total iron contributed from the surface mine reprocessing operation to the surface flow system ranged from 45% to 72% of the total. iron loadings present at the downstream monitoring point.

5. The ferrous iron contributed from the surface mine reprocessing operation to the surface flow system ranged from 12% to 65% of the ferrous iron loadings present at the downstream monitoring point.

Overview

As an overview, Sample Station 1 on Slippery Rock Creek reflects the combined outflow from the duck pond reservoir - Sample Station 3 (composite of waters from Sample Stations 4, 6, 7, and 8), the strip pit and fines washery discharge (Sample Station 5), and the outflow from Sample Station 2 (tributary to Slippery Rock Creek). Therefore, the loadings at Sample Station 1 reflect the gross discharge characteristics of the site (which is principally the entire headwaters watershed of Slippery Rock Creek).

From a monitoring standpoint, the selection of Sample Station 3 allows direct assessment of any changes occurring at Sample Station 4 (Big Bertha well) since the possibility of additional confounding of data from Sample Stations 2 and 5 is eliminated. Further, it was nearly impossible to detect the significant chemical contributions of Big Bertha at Sample Station 3 and this author believes it would be considerably more difficult to detect significant changes further downstream (at Sample Station 1) due to the additional sources.