WATER QUALITY STATUS REPORT NO. 111

POINT AND NONPOINT SOURCE CONTRIBUTIONS OF TRACE HEAVY METALS TO THE SOUTH FORK COEUR D'ALENE RIVER, Shoshone County, Idaho 1989 - 1990

Idaho Department
of Health and Welfare

Division of
Environmental Quality

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Abstract

This study was designed and implemented in an effort to determine the appropriateness of the 304 (l) listing of South Fork Coeur d'Alene River segment PB-130s. Section 304 (l) of the Water Quality Act of 1987 requires each state to list all stream segments that receive point source discharges of toxic pollutants and do not support appropriate beneficial uses even after effluent limitations are in place. In 1989 the U.S. Environmental Protection Agency (EPA) provided funding to the Idaho Division of Environmental Quality to assess the water quality and biotic integrity of the South Fork near Mullan, Idaho in Shoshone County. Water quality information was collected during the 1990 water year. The water chemistry and biological data were used to determine the support status of the beneficial uses and the relevance of the segment boundary listed in Idaho Water Quality Standards.

Specific objectives of this study include the following: 1) determine point source and nonpoint source heavy metals contributions to the South Fork above the Morning District bridge near Mullan, Idaho; 2) determine the effect of heavy metals on aquatic life uses in the study reach; and 3) determine the relevance of the stream segment boundary between stream segments PB-130s and PB-140s.

Metals loading to the South Fork above Mullan, Idaho was modest compared to other reaches within the drainage, as estimated by the 1989-1990 data. Nonpoint source additions were the primary source of heavy metals to the river above Mullan. Between 1989 and 1990 treated waste water from Hecla's Lucky Friday mining operation generally contributed less than 3.0 % of the cadmium, copper and zinc load in the river. Lead contribution to the river from Hecla discharges were generally less than 9%, although low flow total lead contribution from pond 001 was estimated at 42% of the load at the lowest river station.

Fish and benthic macroinvertebrate communities were assessed at all the river stations in the study area. Macroinvertebrate data analysis does not conclusively indicate impairment of the use at the sampling stations from point source additions. Fisheries data was insufficient to determine the effect of point source metals discharges on fish communities at the sampling sites. Due to equipment failures, proper fish collection procedures were not followed therfore, comparisons of population estimates between each sample station were unavialable. However, qualitative analysis of fisheries information do not suggest substantial differences in beneficial use support status throughout the study reach.

Impairment of beneficial uses and/or water chemistry of a waterbody attributed to point source pollution discharges, should be demonstrated in order to warrent 304 (l) listing. The data do not support the 304 (l) listing of segment PB-130s since impairment of cold water biota is not apparent. In addition, water quality data indicate point source contributions of metals to the river in PB-130s are minor compared to nonpoint sources.

Toxicological effects of metals on aquatic organisms (if any) in segment PB-130s cannot be attributed to point source additions within the scope of the current study design.

The information generated in this study was also used to evaluate the appropriateness of the segment boundary location between segments PB-140s and PB-130s. The designated beneficial uses of segment PB-140s (lowermost) differ from the range of uses designated for segment PB-130s. The existence of such a boundary implies beneficial uses change and therefor water quality management changes at a given boundary. However, the observed appropriate beneficial uses do not change throughout the length of the study reach. The beneficial use of cold water biota and salmonid spawning are existing and attainable everywhere in the study reach. These data do not support placement of a segment boundary anywhere within the current study site.

Reliable toxics criteria for cold water biota in the study site apparently are not available. This study documents exceedence of current chronic lead and zinc criteria without any observed effect, attributable to elevated metals concentration, on aquatic biota. This issue can be resolved through development of site specific criteria applicable to waters in the study area. Accurate site specific criteria should subsequently be applied to effluent limitations in order to protect aquatic life uses in the river.

Introduction

Background

The South Fork of the Coeur d'Alene River drains a region called the Silver Valley, Shoshone County, Idaho, which has been severely impacted by historic mining activity, with improvements in water quality since 1972 (Hornig *et al*. 1988). In its upper reaches above the town of Wallace and near the town of Mullan, the river drains a narrow valley and has numerous tributaries which drain steep slopes. In the lower reaches below Wallace, the valley broadens and the river flows over alluvial deposits.

The Idaho Water Quality Standards (IDHW-DEQ 1992) state, from Mullan, Idaho (above mining impacts) to the headwaters, the South Fork Coeur d'Alene River (segment PB-130s) is protected for the following beneficial uses: domestic water supply; agricultural water supply; cold water biota; salmonid spawning; and primary and secondary contact recreation. However, the river below the townsite (PB-140s) is protected for agricultural water supply, secondary contact recreation, with cold water biota and primary contact recreation protected for future use. There are three discharge points from Hecla Mining Company's Lucky Friday mining operation to the South Fork Coeur d'Alene River near Mullan , each from a separate tailings pond: one above town (Pond 003); one in town (Pond 002); and one below town (Pond 001) (figure 1). There is also a NPDES discharge from the South Fork Coeur d'Alene River Sewer District (permit number ID-002130-3-002) below Mullan.

The discharges from the Lucky Friday operation are regulated under the National Pollutant Discharge Elimination System (NPDES) (permit number ID-000017-5). Since heavy metals are discharged above the townsite, the U.S. EPA added segment PB-130s (protected for cold water biota) to the 304(l) list (approximately 1990). The purpose of section 304 (l) of the 1987 Clean Water Act is to identify stream segments with impaired beneficial uses that receive point source additions of toxic materials and subsequently develop individual control strategies to bring the water body into compliance. This study determines the appropriateness of the 304 (l) listing by assessment of the beneficial uses with biological and chemical parameters. In order to warrent 304 (l) listing, impairment of cold water aquatic life uses must be demonstrated in segment PB-130s below the Pond 003 discharge point. This study was funded by U.S. EPA as a result of these issues and was designed and implemented by IDEQ in 1989.

This study ascertains if water quality standards, including protection of the beneficial uses, are being maintained in these river segments with the discharge of Lucky Friday mine's treated wastewater. A complicating factor to be evaluated is possible nonpoint source additions, either from tailings pond leakage, wastes from former mining activity and/or urban runoff.

Prior to 1992 the regulatory boundary between segments PB-130s and PB-140s was thought to be located at the Mullan town site. The boundary location was clarified by Senate Concurrent Resolution 133. The current boundary location (after 1992) is thought to be located at Mullan, Idaho (above the mining impacts). This description places the boundary approximatelty 3.0 stream miles above Mullan at Daisy Gulch.

The current intrepretation of the segment boundary location places the Pond 003 discharge point within segment PB-140s, which is protected for future use of cold water biota. It is important to note that the current boundary interpretation proceeded study design devlopment and the data collection phases of this study. The former interpretation of the segment boundary location in relation to Hecla's uppermost discharge point and the designated uses assigned to segment PB-130s, were issues relevant CWA section 304 (l), and subsequently facilitated funding of this study. These issues have changed with the current Senete resolution of the segment boundary location. However this report will also evaluate the relevance of the regulatory boundary mentioned above, by assessing if future beneficial uses are currently being maintained in the segment below Daisy Gulch (PB-140s) or by determining the support status of existing uses in PB-140s.

Objectives

It is necessary to differentiate between the words segment and reach, as used here. The word "segment" refers to the designations in the Idaho Water Quality Standards. The word "reach" refers to the sections of river separated by river sampling stations. In consideration of these, the specific objectives of this survey are as follows:

(1) Determine the loadings of heavy metals discharged by the Lucky Friday mine to the South Fork of the Coeur d'Alene River near Mullan, Idaho by (a) examining point source waste water flow and metals concentrations and (b) comparing it with nonpoint source additions (based on upstream-downstream differences with point source additions removed);

(2) Assess the appropriateness of 304 (l) listing of segment PB-130s (as determined by former segment boundary interpretation at Mullan) by (a) comparing the observed instream concentrations with water quality criteria for freshwater organisms (EPA 1986), and (b) determining the existence and status of the biota, using intensive level rapid bioassessment protocols (Plafkin *et al.* 1989); and

(3) Determine the relevance of the current segment boundary as described in the Idaho Water Quality Standards with regard to the types of beneficial uses present by (a) determining the status of the beneficial uses in segments PB-130s and PB-140s using the rapid bioassessment protocols (Plafkin *et al.* 1989) and comparing intensive level bioassessments at down stream river sites to an upstream reference site.

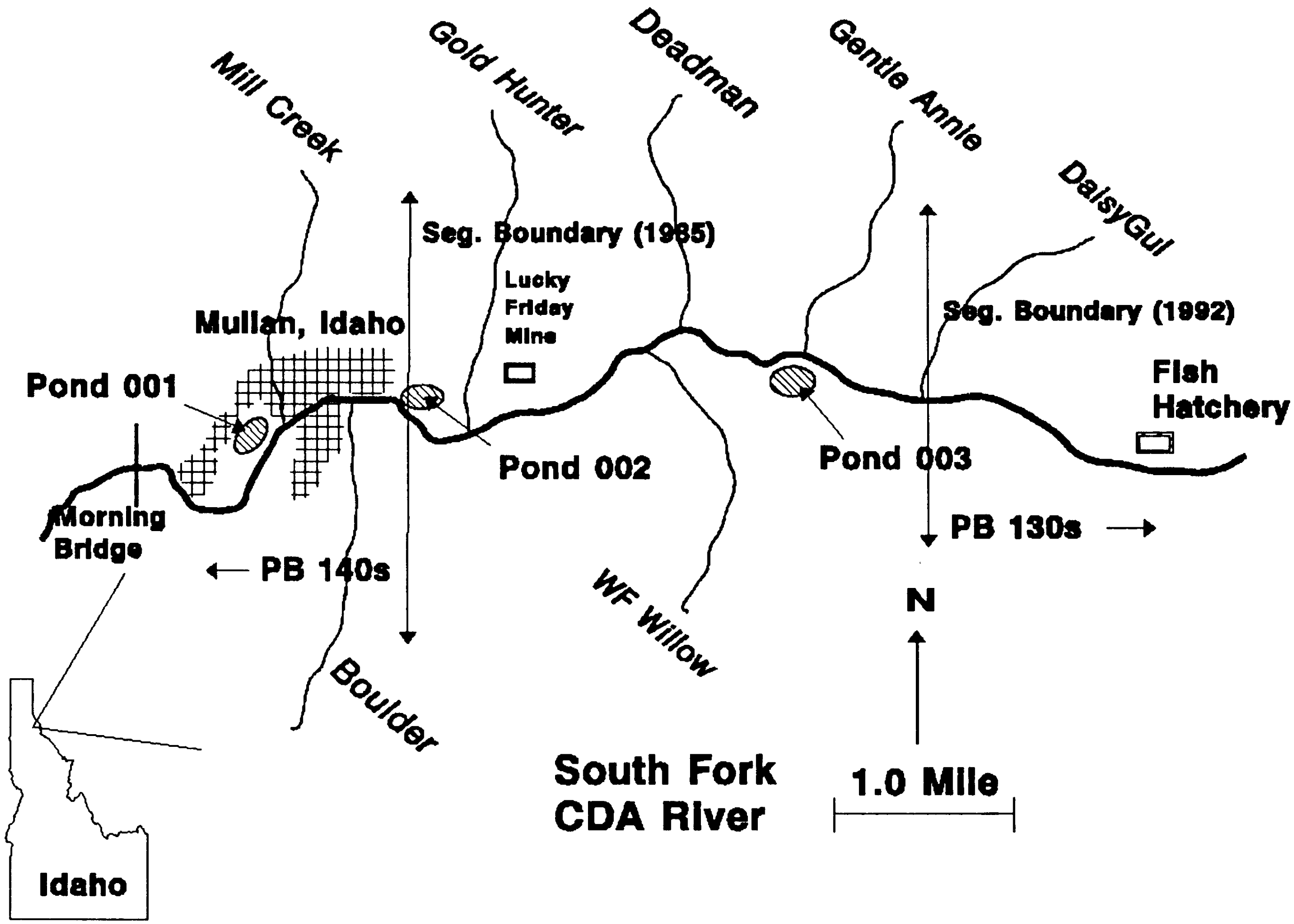

Figure 3 - Location of Permitted Point Source Discharges and the Stream Segment Boundary interpretations before and after 1992.

Materials and Methods

Sample Sites

The reach of river examined is relatively short, approximately four miles in length. However, as stated above , there are three discharge points from the Lucky Friday mining operation and one from the South Fork Coeur d'Alene Sewer District's wastewater treatment facility in the study area (figure 2). All of these point sources were characterized to evaluate the water quality of the river. Figure 2 shows the sampling site locations of river stations and point source stations. Appendix 1 lists station locations and STORET numbers.

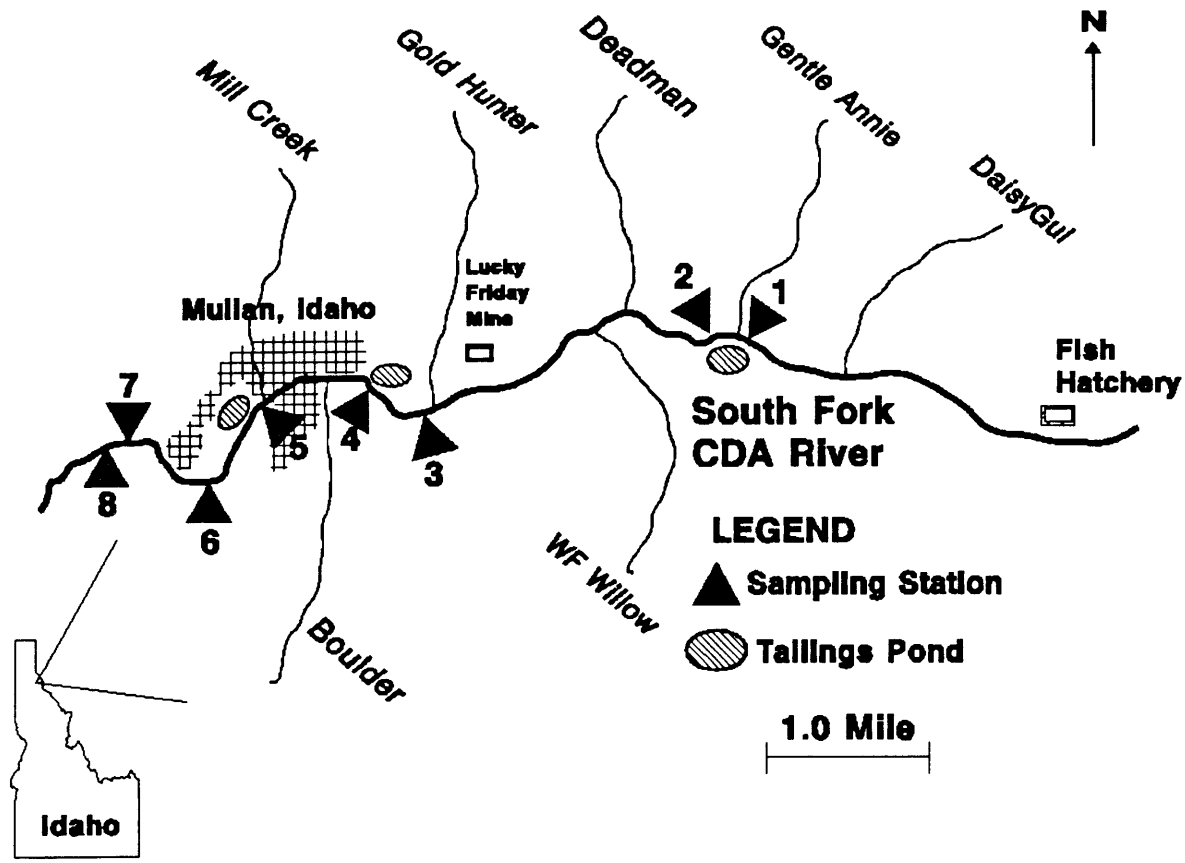

Figure 4 - Sampling Site Locations.

From upstream to downstream, the river stations and discharge points sampled for water quality parameters were as follows:

Station

#1 South Fork of the Coeur d'Alene River above the tailings pond 003 discharge and below Daisy Gulch, at the access bridge to the pond. This site is considered the water quality and biological reference site;

#2 Tailings pond 003 discharge;

#3 South Fork of the Coeur d'Alene River above the tailings pond 002 discharge, at the I-90 access bridge east of Mullan;

#4 Tailings pond 002 discharge;

#5 South Fork of the Coeur d'Alene River above the tailings pond 001 discharge, at the I-90 access bridge in the city of Mullan;

#6 Tailings pond 001 discharge;

#7 City of Mullan wastewater treatment facility discharge (WWTP);

#8 South Fork of the Coeur d'Alene River below the wastewater treatment facility discharge at the Morning District I-90 access bridge.

Biological sampling stations correspond to river stations (#1,#3,#5, and #8).

Frequency and Duration

The study occurred in conjunction with the 1990 water year, from November 1989 through September 1990. Two different flow regimes (strata) were examined: high flow (March through June) and low flow (July through February). For each strata sampling took place randomly, within certain constraints, such as the mine being operational and the personnel available for conducting sampling runs. The number of samples collected from each strata were as follows:

Flow Strata		# of samples
High flow	=	9
Low flow	=	11
Total # of samples	=	20

In addition to sampling runs, an ISCO automatic sampler was installed at river station #8. The sampler collected samples once per day, and at least one sample per week was analyzed for total cadmium, total copper, total lead and total zinc. The ISCO was operated throughout the sampling period.

A Stevens stream stage recorder was installed near river station #8 and operated during the sampling period. The Stevens provided a continuous record of stream stage and enabled discharge and load calculations to be calculate from ISCO sample concentrations.

The benthic macroinvertebrate sampling was performed in low flow conditions of February and August. Fish sampling was performed in August 1990.

Field Procedures

Discharge

Measurement of river discharge was performed by standard USGS methods (Rantz 1982) involving incremental cross-sectional area and velocity measurements with a standard engineers measuring tape (calibrated in feet) and a flow meter (Price AA and Marsh Mcbirney 201D).

In an effort to save time during sampling runs, simple regression equations were used to predict river discharge based on river stage. Regression equation derivation involved measuring from a reference mark located on designated guard rail posts at station bridges to the river surface and measuring the corresponding flow. The measured stage height and measured river flow were linearly correlated and regression equations were developed. At least nine data sets representing all flow conditions (high flow and low flow) were used to calculate the regression equations for each river station.

Discharge from each point source outfall was measured with devices used by Hecla and the South Fork Coeur d'Alene River Sewer District.

Water Chemistry Sampling

Instream water quality samples were collected, processed and preserved in accordance with (Ralston and Brown 1976) using a DH-48 or DH-59 sampler, depending on stream stage. A sample churn splitter was used to collect samples from point source discharges and at river stations. All samples were collected in one liter polypropylene cubitainers, fixed with 1.5 ml of 70% nitric acid and cooled to 4.0 degrees Celsius.

Biological Sampling

Benthic macroinvertebrate and fish collection procedures were in accordance with (Plafkin *et al.* 1989) using a 0.093 m^2 Hess sampler with 0.4 mm mesh size netting. Macroinvertebrate samples were preserved in 80% ethanol and sorted in the laboratory. The macroinvertebrate samples were collected and analyzed by the University of Idaho Department of Zoology, under contract with the Idaho Division of Environmental Quality. The habitat assessment and the final bioassessment at each biological sampling station was made by the IDEQ according to these bioassessment protocols.

Quality Assurance

Sample quality assurance was assessed in accordance with (Bauer 1986). Duplicates of metals, minerals, and residue was collected at least once per month at river station #8 to estimate analytical precision. An additional sample was collected once per month at this station for determination of analytical accuracy of metals and common ions. Each of these samples was spiked with a known concentration of the constituent to be analyzed. A field blank was run once per month to determine if sample contamination from cubitainers, acid or sampling methodology is occurring. Appendix 2 lists quality assurance results.

Water Quality Parameters

The water quality constituents measured and analyzed include the following:

Field Parameters
- flow (all stations);
- temperature (river stations);
- dissolved oxygen concentration (river stations);
- specific conductance (all stations);
- pH (all stations);

Solids
- suspended solids (all stations);

Common Ions
- total alkalinity (all stations);
- hardness (all stations);

Total and dissolved Metals
- cadmium (all stations);
- copper (all stations);
- lead (all stations);
- zinc (all stations);

Biological Constituents
- benthic macroinvertebrates (river stations);
- fish (river stations);

Results and Discussion

Discharge

A continuous record of stream discharge from the South Fork Coeur d'Alene River above the Morning bridge (figure 1) was graphed for water year 1990. A Stevens continuous recorder was used at river station #8 to measure river stage over time. The stage discharge relationship ($r^2 = 0.97$) developed at station #8 was used to predict flow based on stage. Figure 3 shows the hydrograph of the South Fork. Tick marks along the hydrograph indicate the timing of water quality sampling and provide a visual estimate of flow intensity during sampling.

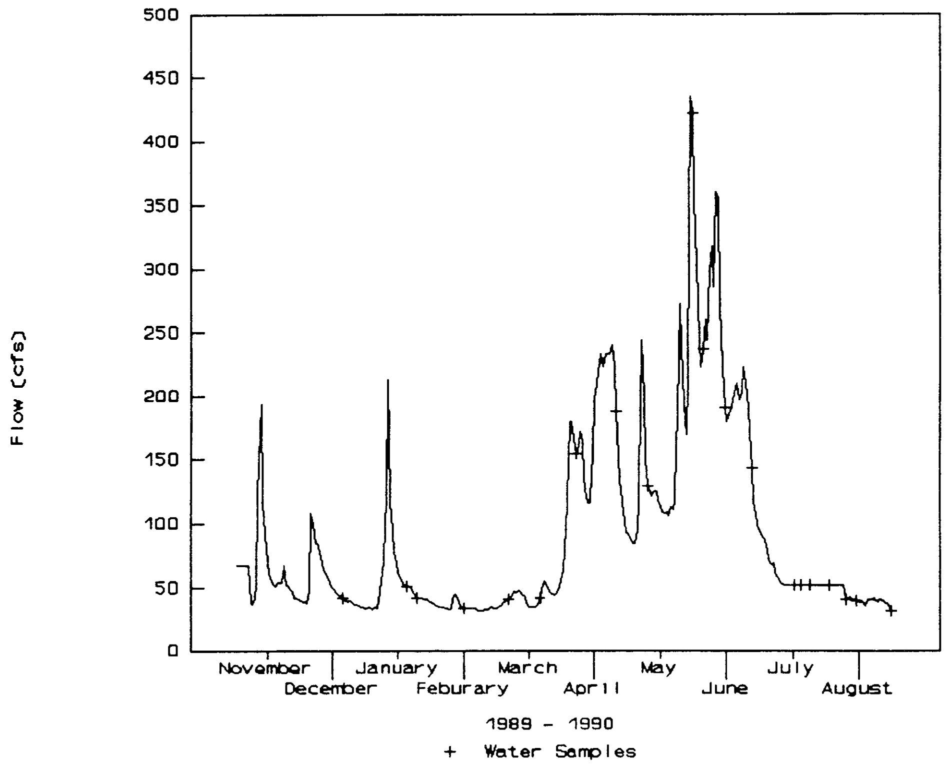

Figure 5 - Hydrograph of the South Fork Coeur d'Alene River for Water Year 1990.

The river was higher than base flow between November 1989 and February 1990 with three spikes in discharge in November, December and January. The hydrograph began to rise in late March 1990 and reached the first sustained peak of 240 cfs at mid April. The river reached a second sustained peak in late May of 435 cfs. Stream discharge fell During June 1990. The river was at approximately base flow in August and fell to a minimum of 31.8 cfs.

Stage discharge relationships were developed at river stations #1, #3, #5 and #8 to lessen the work load during water quality sampling runs. This allowed for discharge estimates during sampling runs using a direct stage measurement. It was necessary to calculate angle coefficients at stations #1 and #5 because the bridges at these sites deviated slightly from perpendicular. Angle coefficients were used to correct the measured discharge when flow was measured from a bridge (high flow). Stage discharge data for each river station and respective regression outputs are listed in appendix 3.

Water Quality Sampling

Water quality samples were taken at eight stations during the period between December 1989 and August 1990. Stations #1 and #3 are river stations located in segment PB-140s (IDHW-DEQ 1992) with station #1 being a reference site (above point source discharges). Stations #5 and #8 are located in segment PB-140s (IDHW 1992) below the townsite of Mullan. Stations #2 (Hecla pond 003), #4 (Hecla pond 002), #6 (Hecla pond 001) and #7 (Mullan WWTP) are permitted point source discharges. Figure 2 shows the locations of all sampling sites.

A total of 20 water samples were collected at each station during the sampling period. A total of nine samples were collected during the high flow period between March 1990 and June 1990. A total of 11 samples were collected during the low flow period between November 1989 through February 1990 and July 1990 through August 1990. At each river station, an accompanying stage measurement was taken with each water sample in order to obtain a flow estimate and loading calculation. Flow measurements at point source stations were obtained from monthly flow records supplied by Hecla personnel and South Fork Coeur d'Alene Sewer District personnel..

Instream Concentrations

Water Quality Criteria

In regard to fresh water organisms, the Environmental Protection Agency has identified acute (short term) and chronic (long term) exposure limits to toxic substances (EPA 1986). Aquatic organisms should not be affected unacceptably if the one hour average concentration does not exceed acute exposure criteria and the four day average concentration does not exceed chronic exposure criteria.

The toxicity of heavy metals cadmium, copper, lead and zinc have been determined to be hardness dependent. In general, as hardness decreases, toxicity of these metals increase. Tables 1 through 4 include equations used to determine acute and chronic criteria for fresh water organisms based on an annual average hardness at station #8 of 43 mg/L (as $CaCo_3$).

Grab Samples

Objective 2a of this study is to compare instream concentrations at river stations to water quality criteria for freshwater organisms (EPA 1986) and determine if instream concentrations are within accepted limits. The data generated in this study was insufficient to make comparisons of instream concentrations and acute criteria. Valid comparisons of instream concentrations and acute water quality criteria would probably require replicate sampling during a one hour period. It is possible to compare chronic criteria to average instream concentrations if the trend data is stratified to minimize seasonal variability. Students t-tests were run on low flow sample populations to test for significant difference between mean concentrations and criteria. For the purposes of this analysis, only dissolved fractions of cadmium, copper, lead and zinc at low flow were compared to water quality criteria since: bioavailability of total metal fractions is unclear; laboratory precision of total faction analysis is less reliable than that of dissolved (Albertson, personal communication 1992); and instream concentrations of dissolved fractions apparently have the least variability at low flow, and aquatic organisms are likely to be most stressed during low flow conditions.

Instream grab sample concentrations at river stations for each sampling date are shown in tables 1-4. Mean concentrations for three time periods annual, high flow and low flow were computed. 95% confidence intervals (t-distribution) around each sample mean and detection limits for each metal is also listed. Detection limits of all metals were lowered from that of standard to provide the resolution necessary for trace heavy metal analysis. Samples concentrations below detection were reported as one half the lower detection concentration.

A total cadmium concentration of 6.0 ppb was measured at station #1 on May 9, 1990. The validity of this concentration is unclear due to lack of replication in the trend oriented sampling design. Quality assurance results for cadmium indicate adequate precision and no significant contamination from field procedures. Outliers such as this occasionally occurred at various stations. In some instances possible outliers in sample populations increase the variability in the sample populations making statistical comparisons of concentrations inappropriate. As a result, only mean sample population concentrations with reasonably tight confidence intervals should be considered reliable. In addition, mean concentrations below detection limits should be recognized as being hypothetical estimations (based on one half the detection limit).

Table 1 - Instream Concentrations of Cadmium at River Stations #1, #3, #5 and #8.

SAMPLE DATE	Station #1 TOTAL CD. (ppb)	DISSL. CD. (ppb)	Station #3 TOTAL CD. (ppb)	DISSL. CD. (ppb)	Station #5 TOTAL CD. (ppb)	DISSL. CD. (ppb)	Station #8 TOTAL CD. (ppb)	DISSL. CD. (ppb)	
12/20/89	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
01/19/90	0.25	0.25	0.25	0.25	0.25	0.25	0.70	0.50	
01/24/90	0.25	0.25	0.25	0.25	0.25	0.25	0.80	0.60	
02/15/90	0.60	0.25	0.25	0.25	0.25	0.25	0.70	0.25	
03/05/90	0.25	0.25	0.25	0.25	0.25	0.25	0.80	0.25	
03/20/90	0.25	0.25	0.25	0.25	0.25	0.25	0.50	0.50	
04/16/90	0.25	0.25	0.25	0.25	0.25	0.25	1.10	0.60	
04/25/90	0.25	0.25	0.25	0.25	0.25	0.25	0.60	1.00	
05/09/90	6.00	0.25	0.25	0.25	0.25	0.25	0.50	0.25	
05/30/90	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
06/04/90	0.25	0.25	0.25	0.25	0.25	0.25	0.50	0.25	
06/14/90	0.25	0.25	0.90	0.50	0.25	0.25	0.70	0.25	
06/27/90	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
07/16/90	0.25	0.25	0.25	0.25	0.25	0.25	0.70	0.70	
07/19/90	0.25	0.25	0.25	0.25	1.00	0.25	0.80	0.50	
07/23/90	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
08/01/90	0.25	0.25	0.25	0.25	0.25	0.25	0.50	0.50	
08/09/90	0.25	0.25	0.25	0.25	0.25	0.25	0.50	0.50	
08/14/90	0.25	0.25	0.25	0.25	0.25	0.25	0.60	0.60	
08/30/90	0.25	0.25	0.25	0.25	0.25	0.25	0.60	0.60	
Mean Annual Conc.	0.57	0.26	0.30	0.28	0.30	0.26	0.59	0.46	
n:	20	20	20	20	20	20	20	20	
STD:	1.25	0.05	0.15	0.08	0.17	0.05	0.20	0.20	
$t_{0.5/2}$:	2.093	2.093	2.093	2.093	2.093	2.093	2.093	2.093	
CI (± mean Conc.):	0.60	0.03	0.07	0.04	0.08	0.03	0.10	0.10	
Mean High Flow Conc.	0.89	0.25	0.32	0.28	0.25	0.25	0.58	0.40	
n:	9	9	9	9	9	9	9	9	
STD:	1.81	0.00	0.20	0.08	0.00	0.00	0.25	0.25	
$t_{0.5/2}$:	2.306	2.306	2.306	2.306	2.306	2.306	2.306	2.306	
CI (± mean Conc.):	1.47	0.00	0.17	0.06	0.00	0.00	0.21	0.20	
Mean Low Flow Conc.	0.30	0.27	0.27	0.27	0.34	0.27	0.60	0.50	
n:	11	11	11	11	11	11	11	11	
STD:	0.12	0.07	0.07	0.07	0.22	0.07	0.15	0.13	
$t_{0.5/2}$:	2.228	2.228	2.228	2.228	2.228	2.228	2.228	2.228	
CI (± mean Conc.):	0.08	0.05	0.05	0.05	0.16	0.05	0.11	0.09	

Acute Exposure = 1.4ppb
(1.128XLn(hardness)-3.828)

Chronic Exposure = 0.64ppb
(0.7852XLn(hardness)-3.490)

Hardness = 43 mg/L

Lower Detection = 0.5ppb

High Flow (Mar-June)
Low Flow (July-Feb)

Table 2 - Instream Concentrations of Copper at River Stations #1, #3, #5 and #8

SAMPLE DATE	Station #1 TOTAL CU. (ppb)	DISSL. CU. (ppb)	Station #3 TOTAL CU. (ppb)	DISSL. CU. (ppb)	Station #5 TOTAL CU. (ppb)	DISSL. CU. (ppb)	Station #8 TOTAL CU. (ppb)	DISSL. CU. (ppb)	Acute Exposure = 5.6 ppb (0.9422XLn(hardness)-1.464)
12/20/89	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	Chronic Exposure = 4.3 ppb
01/19/90	13.00	1.25	11.00	1.00	7.00	2.00	12.00	4.00	(0.8545XLn(hardness)-1.464)
01/24/90	14.00	35.00	11.00	4.00	11.00	4.00	13.00	3.00	
02/15/90	5.00	1.50	6.00	1.50	17.00	1.50	4.50	1.50	Hardness = 43 mg/L
03/05/90	7.00	2.00	8.00	2.00	6.00	1.00	7.00	7.00	
03/20/90	6.00	2.00	7.00	2.00	6.00	2.00	6.00	2.00	Lower Detection = 3.0 ppb
04/16/90	9.00	3.00	9.00	2.00	8.00	1.00	9.00	2.00	
04/25/90	9.00	1.00	7.00	3.00	8.00	1.00	11.00	3.00	High Flow (Mar-June)
05/09/90	11.00	1.00	13.00	12.00	3.00	1.00	3.00	1.00	Low Flow (July-Feb)
05/30/90	19.00	1.50	21.00	1.50	17.00	1.50	11.00	1.50	
06/04/90	7.00	1.00	3.00	1.00	3.00	1.00	4.00	1.00	
06/14/90	8.00	1.50	8.00	1.50	6.00	1.50	6.00	1.50	
06/27/90	5.00	1.50	5.00	3.00	16.00	1.50	5.00	4.00	
07/16/90	1.00	1.00	2.00	1.00	3.00	2.00	3.00	1.00	
07/19/90	4.00	1.50	5.00	1.50	4.00	1.50	3.00	3.00	
07/23/90	3.00	3.00	4.00	3.00	1.50	1.50	5.00	1.50	
08/01/90	8.00	1.50	12.00	1.50	10.00	1.50	8.00	3.00	
08/09/90	7.00	1.50	4.00	1.50	9.00	1.50	7.00	1.50	
08/14/90	6.00	3.00	8.00	1.50	9.00	5.00	7.00	3.00	
08/30/90	7.00	3.00	7.00	1.50	8.00	3.00	6.00	1.50	
Mean Annual Conc.	7.70	3.59	7.80	2.55	7.88	2.00	6.78	2.55	
n:	20	20	20	20	20	20	20	20	
STD:	4.00	7.27	4.21	2.40	4.45	1.22	2.96	1.51	
$t_{0.5/2}$:	2.093	2.093	2.093	2.093	2.093	2.093	2.093	2.093	
CI (± mean Conc.):	1.92	3.49	2.02	1.15	2.14	0.59	1.42	0.72	
Mean High Flow Conc.	9.00	1.61	9.00	3.11	8.11	1.28	6.89	2.56	
n:	9	9	9	9	9	9	9	9	
STD:	3.92	0.61	4.97	3.20	4.79	0.34	2.73	1.82	
$t_{0.5/2}$:	2.306	2.306	2.306	2.306	2.306	2.306	2.306	2.306	
CI (± mean Conc.):	3.19	0.50	4.05	2.61	3.91	0.28	2.22	1.48	
Mean Low Flow Conc.	6.64	5.20	6.82	2.09	7.68	2.59	6.68	2.55	
n:	11	11	11	11	11	11	11	11	
STD:	3.75	9.49	3.16	1.26	4.14	1.36	3.14	1.20	
$t_{0.5/2}$:	2.228	2.228	2.228	2.228	2.228	2.228	2.228	2.228	
CI (± mean Conc.):	2.64	6.69	2.22	0.89	2.91	0.96	2.21	0.84	

Table 3 - Instream Concentrations of Lead at River Stations #1, #3, #5 and #8.

SAMPLE DATE	Station #1 TOTAL PB. (ppb)	DISSL. PB. (ppb)	Station #3 TOTAL PB. (ppb)	DISSL. PB. (ppb)	Station #5 TOTAL PB. (ppb)	DISSL. PB. (ppb)	Station #8 TOTAL PB. (ppb)	DISSL. PB. (ppb)	Acute Exposure = 16.0 ppb (1.273XLn(Hardness)-1.460)
12/20/89	2.50	2.50	2.50	2.50	130.00	2.50	2.50	2.50	Chronic Exposure = 1.1 ppb
01/19/90	1.25	1.25	2.50	1.25	4.00	1.25	4.80	1.25	(1.273XLn(Hardness)-4.705)
01/24/90	1.50	1.50	3.00	1.50	6.00	1.50	7.00	3.00	
02/15/90	6.40	1.50	9.50	1.50	33.00	1.50	18.00	1.50	Hardness = 43 mg/L
03/05/90	1.25	1.25	16.00	1.25	22.00	3.00	23.00	5.00	
03/20/90	3.00	1.50	7.00	1.50	13.00	1.50	13.00	4.00	Lower Detection = 5 ppb
04/16/90	7.00	1.25	11.00	1.25	25.00	1.25	15.00	3.40	
04/25/90	4.40	1.25	8.00	1.25	11.00	1.25	12.00	1.25	High Flow (Mar-June)
05/09/90	14.70	3.40	12.90	2.50	14.40	1.25	11.70	4.10	Low Flow (July-Feb)
05/30/90	33.00	7.20	15.00	2.90	13.00	1.25	18.00	2.60	
06/04/90	9.60	1.25	21.00	2.50	9.80	1.25	11.00	3.80	
06/14/90	1.50	1.50	6.00	1.50	5.00	1.50	14.00	4.00	
06/27/90	4.00	1.50	3.00	1.50	8.00	3.00	9.00	8.00	
07/16/90	3.10	1.25	2.70	1.25	3.20	1.25	8.80	3.20	
07/19/90	1.50	1.50	3.00	1.50	3.00	1.50	8.00	6.00	
07/23/90	3.00	1.50	4.00	1.50	6.00	1.50	11.00	7.00	
08/01/90	3.00	3.00	1.50	1.50	3.00	1.50	8.00	7.00	
08/09/90	1.50	1.50	1.50	1.50	1.50	1.50	12.00	9.00	
08/14/90	6.00	1.50	8.00	3.00	5.00	4.00	13.00	8.00	
08/30/90	1.50	5.00	3.00	1.50	4.00	3.00	18.00	7.00	
Mean Annual Conc.	5.49	2.11	7.06	1.73	16.00	1.81	11.89	4.58	
n:	20	20	20	20	20	20	20	20	
STD:	7.12	1.49	5.45	0.57	27.38	0.79	4.82	2.34	
$t_{0.5/2}$:	2.093	2.093	2.093	2.093	2.093	2.093	2.093	2.093	
CI (± mean Conc.):	3.42	0.72	2.62	0.27	13.15	0.38	2.31	1.13	
Mean High Flow Conc.	8.72	2.23	11.10	1.79	13.47	1.69	14.08	4.02	
n:	9	9	9	9	9	9	9	9	
STD:	9.49	1.87	5.36	0.61	6.04	0.70	3.98	1.73	
$t_{0.5/2}$:	2.306	2.306	2.306	2.306	2.306	2.306	2.306	2.306	
CI (± mean Conc.):	7.74	1.53	4.37	0.50	4.92	0.57	3.24	1.41	
Mean Low Flow Conc.	2.84	2.00	3.75	1.68	18.06	1.91	10.10	5.04	
n:	11	11	11	11	11	11	11	11	
STD:	1.72	1.08	2.47	0.52	36.38	0.84	4.71	2.66	
$t_{0.5/2}$:	2.228	2.228	2.228	2.228	2.228	2.228	2.228	2.228	
CI (± mean Conc.):	1.21	0.76	1.74	0.37	25.63	0.59	3.32	1.87	

Table 4 - Instream Concentrations of Zinc at River Stations #1, #3, #5 and #8.

SAMPLE DATE	Station #1 TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	Station #3 TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	Station #5 TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	Station #8 TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	Notes
									Acute Exposure = 29.1 ppb (0.8473XLn(Hardness)+0.8604)
12/20/89	5.00	5.00	5.00	5.00	10.00	20.00	120.00	100.00	Chronic Exposure = 26.8 ppb
01/19/90	4.00	4.00	7.00	7.00	22.00	16.00	150.00	144.00	(0.8473XLn(Hardness)+0.7614)
01/24/90	7.00	7.00	16.00	8.00	22.00	17.00	149.00	144.00	
02/15/90	4.00	1.00	11.00	1.00	26.00	1.00	152.00	1.00	Hardness = 43 mg/L
03/05/90	282.00	2.00	14.00	4.00	46.00	18.00	155.00	147.00	
03/20/90	3.00	3.00	10.00	8.00	24.00	18.00	153.00	152.00	Lower Detection = 5 ppb
04/16/90	17.00	9.00	27.00	8.00	29.00	9.00	117.00	45.00	
04/25/90	18.00	10.00	20.00	11.00	28.00	12.00	68.00	39.00	High Flow (Mar-June)
05/09/90	8.00	7.00	12.00	12.00	12.00	11.00	119.00	50.00	Low Flow (July-Feb)
05/30/90	19.00	5.00	108.00	5.00	25.00	5.00	65.00	34.00	
06/04/90	5.00	8.00	15.00	9.00	48.00	10.00	68.00	55.00	
06/14/90	14.00	6.00	46.00	6.00	17.00	6.00	61.00	54.00	
06/27/90	13.00	7.00	4.00	4.00	31.00	8.00	50.00	48.00	
07/16/90	11.00	1.00	12.00	3.00	23.00	14.00	96.00	80.00	
07/19/90	5.00	1.50	12.00	4.00	15.00	11.00	86.00	78.00	
07/23/90	11.00	5.00	0.25	0.25	11.00	9.00	89.00	90.00	
08/01/90	12.00	8.00	10.00	5.00	16.00	12.00	102.00	97.00	
08/09/90	8.00	6.00	9.00	8.00	22.00	16.00	115.00	112.00	
08/14/90	12.00	5.00	20.00	6.00	27.00	18.00	117.00	104.00	
08/30/90	19.00	8.00	21.00	10.00	35.00	21.00	125.00	113.00	
Mean Annual Conc.	23.85	5.43	18.96	6.21	24.45	12.60	107.85	84.35	
n:	20	20	20	20	20	20	20	20	
STD:	59.44	2.61	22.54	3.03	9.99	5.26	33.19	42.10	
$t_{0.5/2}$:	2.093	2.093	2.093	2.093	2.093	2.093	2.093	2.093	
CI (± mean Conc.):	28.54	1.26	10.82	1.46	4.80	2.52	15.93	20.22	
Mean High Flow Conc.	42.11	6.33	28.44	7.44	28.89	10.78	95.11	69.33	
n:	9	9	9	9	9	9	9	9	
STD:	84.98	2.49	30.38	2.75	11.20	4.39	38.82	43.33	
$t_{0.5/2}$:	2.306	2.306	2.306	2.306	2.306	2.306	2.306	2.306	
CI (± mean Conc.):	69.29	2.03	24.77	2.24	9.13	3.58	31.65	35.33	
Mean Low Flow Conc.	8.91	4.68	11.20	5.20	20.82	14.09	118.27	96.64	
n:	11	11	11	11	11	11	11	11	
STD:	4.40	2.47	5.88	2.88	7.04	5.43	22.98	36.77	
$t_{0.5/2}$:	2.228	2.228	2.228	2.228	2.228	2.228	2.228	2.228	
CI (± mean Conc.):	3.10	1.74	4.14	2.03	4.96	3.83	16.19	25.90	

Cadmium

Average dissolved cadmium concentrations at all river stations were generally below the detection limit of 0.5 ppb. There appeared to be an increase in dissolved cadmium concentrations between station #5 and #8, however dissolved cadmium concentrations were lower than chronic exposure criteria (0.64 ppb) at station #8 (Table 1).

Copper

Mean dissolved copper concentrations were below the detection limit of 3 ppb at all stations except reference station #1 where the annual mean concentration was 3.59 ppb and the low flow mean was 5.20 ppb. An outlier in the dissolved copper data set appears to make the low flow mean concentration suspect. Dissolved copper concentrations were below chronic (4.3 ppb) exposure limits at all river stations. There did not appear to be an increase in dissolved copper concentrations between station #1 and #8.

lead

Mean dissolved lead concentrations at stations #1, #3 and #5 exceeded chronic exposure criteria for each time regime however, lead concentrations were below the dissolved lead detection limit of 2.5 ppb at those stations. At station #8, mean dissolved lead concentrations exceeded chronic exposure criteria and were above lower detection limits (#1, #3 and #5 diss. concs. were below detection). Mean dissolved lead concentrations increased between stations #5 and #8 from <2.5 ppb to 5.0 ppb at low flow (table 3).

Zinc

Mean dissolved zinc concentrations were above detection limits at all river stations. Zinc concentrations at stations #1, #3 and #5 were below chronic (26.8 ppb) exposure criteria. At station #8, mean dissolved zinc concentrations exceeded chronic exposure criteria. Mean dissolved zinc concentrations at low flow increased substantially between stations #5 and #8 from 14.0 ppb to 96.6 ppb. Instream dissolved zinc concentrations exceed acute and chronic criteria at station #8 (table 4).

Table 5 provides a summary of comparisons between water quality criteria and mean dissolved concentration. Statistical significance of comparision tests are noted in table 5.

Mean concentrations at all sampling stations are summarized in appendix 4. Derived concentrations of nonpoint sources are also summarized in appendix 4.

Table 5 - Water Quality Criteria Summary.

	Concentrations			
	Diss. Cd.	Diss. Cu.	Diss. Pb.	Diss. Zn.
Station #1				
High Flow Conc.	< Chronic	< Chronic	> Chronic	< Chronic
Low Flow Conc.	< Chronic ****	> Chronic	> Chronic ***	< Chronic ****
Station #3				
High Flow Conc.	< Chronic	< Chronic	> Chronic	< Chronic
Low Flow Conc.	< Chronic ****	< Chronic ****	> Chronic	< Chronic ****
Station #5				
High Flow Conc.	< Chronic	< Chronic	> Chronic	< Chronic
Low Flow Conc.	< Chronic ****	< Chronic ****	> Chronic ****	< Chronic ****
Station #8				
High Flow Conc.	< Chronic	< Chronic	> Chronic	> Chronic
Low Flow Conc.	< Chronic ****	< Chronic ****	> Chronic ****	> Chronic ****

* = $t_{0.1}$
** = $t_{0.05}$
*** = $t_{0.025}$
**** = $t_{0.01}$

ISCO Samples

An ISCO automatic sampler was installed at river station #8 and set to collect one sample per day. At least one sample per week was obtained during the sampling period, however the equipment was not operational during late May, June and July. Figure 4 shows the 1990 hydrograph with tick marks representing analyzed ISCO samples.

ISCO samples were analyzed for total factions of cadmium, copper, lead and zinc. Appendix 5 lists instream concentrations of metals and corresponding loads for all ISCO samples. In addition, mean annual, high flow, low flow concentrations and respective 95% confidence intervals are tabulated.

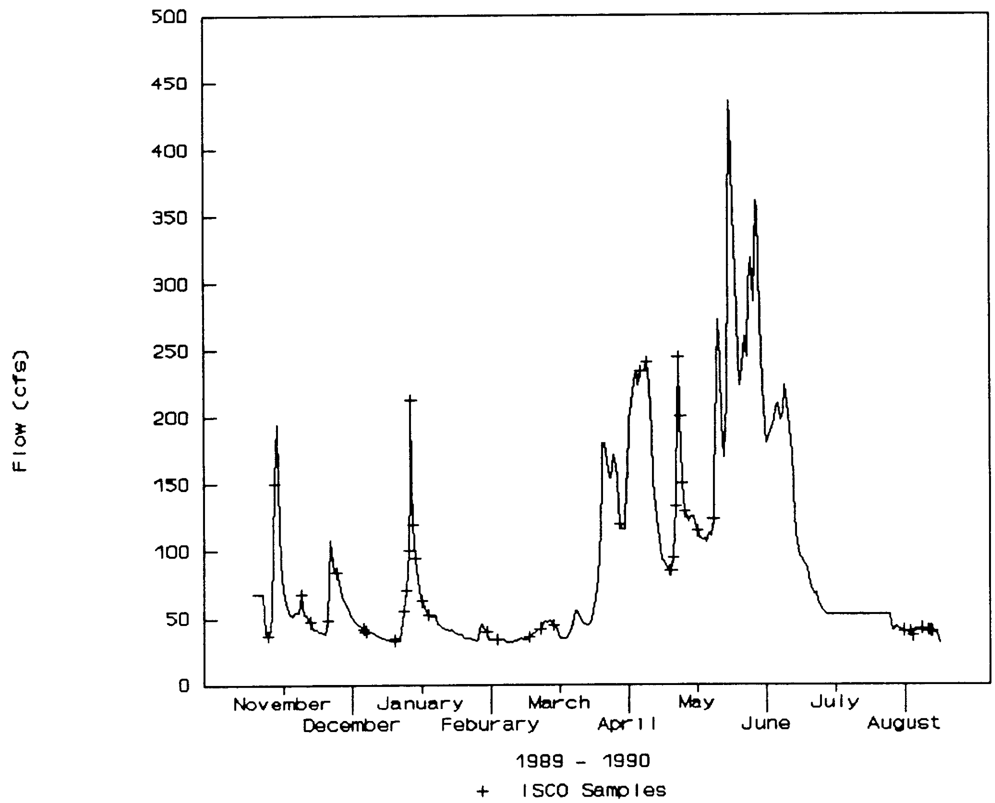

Figure 6 - Illustration of Analyzed Isco Samples Taken During the 1990 Water Year.

Daily Loading

Mean daily loadings of metals for each time regime at all stations were calculated. In addition, mean daily loading from nonpoint sources were computed for each reach in the study site (nonpoint load derivation will be discussed later). Daily loading was reported in kilograms per day and was determined by multiplying concentration (ppb), flow (cfs) and a derived factor of 0.0024465. Table 5 summarizes mean daily metals loads at river stations, point source outfalls and nonpoint loading in various river reaches. Daily metals load at specific locations will be discussed the section on percent contribution.

Mean daily loads represent the average of daily loads calculated for each sample in the three populations. The annual sample population include all samples taken in during the sampling period. The high flow sample population includes all samples taken between March 1990 and June 1990. The low flow sample population include samples taken between December 1989 through February 1990 and July 1990 through August 1990. Possible sources of error in daily load estimates include non-accounted natural variability, variability in discharge estimations and variability in laboratory and field precision and accuracy.

Unexplained variation of discharge data was observed at river station #3. Discharge estimates obtained from stage measurements were generally higher at station #3 than down stream at station #5. This indicates the reach between #3 and #5 losses water to subsurface flow however, direct discharge measurements taken at all flow regimes do not indicate decreasing surface flow from #3 down to #5. Because of this discrepancy, loading estimates from river station #3 were not used in load or percent contribution analysis.

Daily loads of cadmium, lead and zinc leaving the South Fork Coeur d'Alene River above station #8 were relatively modest compared to other high metal loading stream reaches in the South Fork drainage (MuCulley Frick and Gilman 1991a; 1991b; 1992). Figure 5 shows mean daily high flow loads of total and dissolved metals leaving at station #8. Figure 6 shows loads leaving the South Fork at station #8 during low flow. These computed values will be referred to in later discussions of percent contribution of point and nonpoint source additions to river loading.

Appendix 4 summarizes mean daily loads, mean concentrations at all sampling stations and derived nonpoint concentrations and loads.

Table 6 - Summary of mean daily Load estimates at sampling stations on the South Fork Coeur d'Alene River during high flow and low flow.

Station	Cadmium (kgs/day)			Copper (kgs/day)			Lead (kgs/day)			Zinc (kgs/day)		
	Annual	High	Low	Annual	High	Low	Annual	High	Low	Annual	High	Low
	Total Fraction											
River Station #1	0.030	0.049	0.017	0.929	1.652	0.423	0.565	1.158	0.149	2.461	5.187	0.553
PS Stat #2 (003)	0.001	0.001	0.001	0.016	0.022	0.012	0.115	0.186	0.064	0.114	0.174	0.071
PS Stat #4 (002)	0.000	0.000	0.000	0.001	0.001	0.001	0.006	0.008	0.005	0.018	0.021	0.015
River Station #5	0.049	0.078	0.028	1.292	2.441	0.489	2.005	4.318	0.386	4.083	7.782	1.494
NP(#1 to #5)	0.017	0.027	0.010	0.346	0.765	0.052	1.320	2.966	0.167	1.491	2.400	0.854
PS Stat #6 (001)	0.002	0.002	0.002	0.021	0.026	0.018	0.415	0.443	0.395	0.384	0.454	0.335
PS Stat #7 WWTP	0.002	0.003	0.001	0.020	0.025	0.016	0.041	0.077	0.015	0.384	0.630	0.212
River Station #8	0.137	0.242	0.064	1.478	2.521	0.748	2.456	4.603	0.953	20.513	32.173	12.352
NP(#5 to #8)	0.085	0.158	0.034	0.145	0.030	0.226	-0.005	-0.235	0.156	15.662	23.307	10.310
NP(Above #8)	0.133	0.235	0.061	1.420	2.447	0.701	1.879	3.888	0.473	19.614	30.894	11.717
	Dissolved Fraction											
River Station #1	0.030	0.049	0.017	0.349	0.330	0.363	0.208	0.335	0.120	0.784	1.478	0.298
PS Stat #2 (003)	0.001	0.001	0.000	0.006	0.008	0.005	0.013	0.018	0.010	0.055	0.083	0.035
PS Stat #4 (002)	0.000	0.000	0.000	0.001	0.001	0.000	0.004	0.005	0.003	0.017	0.021	0.015
River Station #5	0.045	0.078	0.021	0.273	0.371	0.204	0.288	0.495	0.143	1.985	3.162	1.162
NP(#1 to #5)	0.014	0.028	0.004	-0.083	0.033	-0.164	0.062	0.137	0.009	1.129	1.580	0.814
PS Stat #6 (001)	0.001	0.002	0.001	0.007	0.007	0.007	0.188	0.189	0.187	0.300	0.305	0.297
PS Stat #7 WWTP	0.001	0.002	0.001	0.007	0.009	0.006	0.006	0.008	0.005	0.334	0.547	0.184
River Station #8	0.105	0.175	0.056	0.514	0.828	0.294	0.879	1.338	0.558	14.691	19.336	11.440
NP(#5 to #8)	0.057	0.093	0.032	0.227	0.441	0.078	0.398	0.646	0.224	12.685	15.322	9.797
NP(Above #8)	0.101	0.170	0.053	0.494	0.804	0.276	0.668	1.118	0.353	13.985	18.380	10.909

NP=Nonpoint, PS=Point Source, WWTP=Waste Water Treatment Plant (municipal)

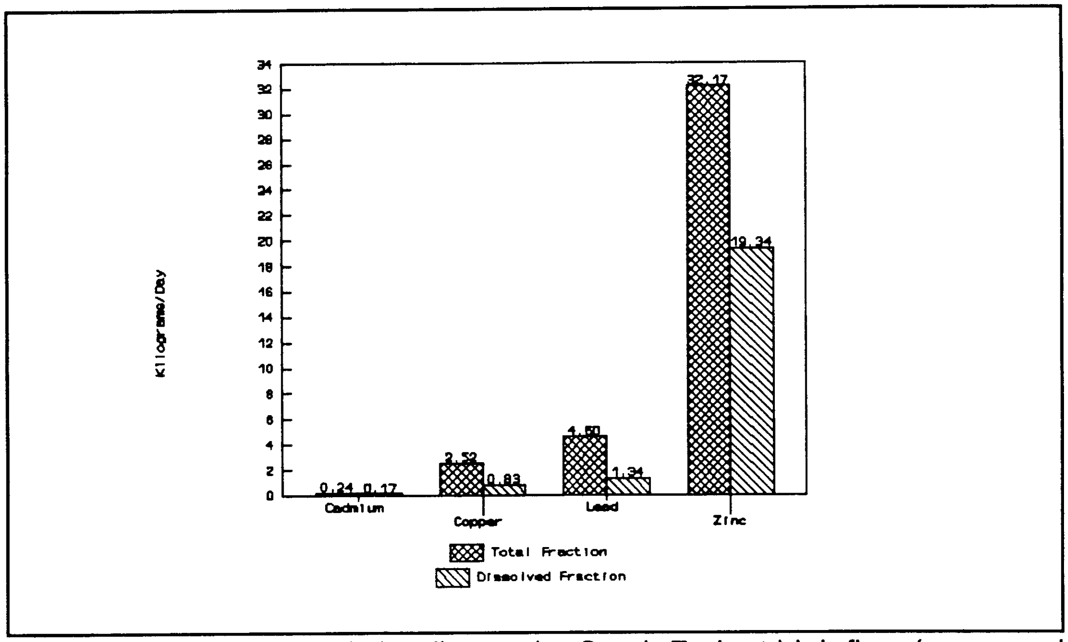

Figure 7 - Daily metals loading to the South Fork at high flow (measured at station #8).

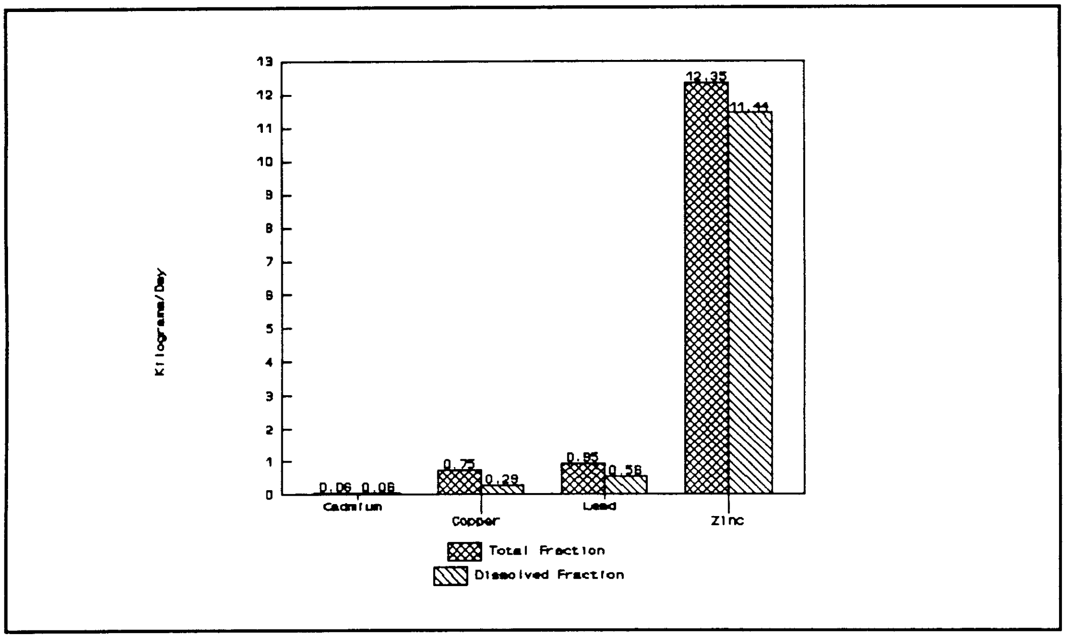

Figure 8 - Daily metals loading to the South Fork at low flow (measured at station #8).

Nonpoint Source Loading

Computation of nonpoint source loading involved simple mass balance calculations. Nonpoint source load in a given river reach equals the difference between down stream river load, upstream river load and point source load within the reach.

Three river reaches were identified in the study area (figure 7). Nonpoint source additions to each reach were calculated using mass balance calculations. Originally four river reaches were identified but removal of station #3 loading data prevents delineation of nonpoint loads between #1 and #3. Equations used to derived nonpoint source loads in each reach are described below.

Reach 1 - This reach extends from the South Fork headwaters to reference station #1. There are no point sources above #1 therefor river load (metals) at #1 is 100% nonpoint.

Reach 2 - This reach extends from river station #1 down to river station #5. Two point source outfalls are located in this reach, station #2 (pond 003) and station #4 (pond 002).

NP(reach 2) = (#5 - #1 - #2 - #4)

Reach 3 - This reach extends from river station #5 down to river station #8. Two point source outfalls are located in this reach, station #6 (pond 001) and station #7 (municipal WWTP).

NP(reach 3) = (#8 - #5 - #6 - #7)

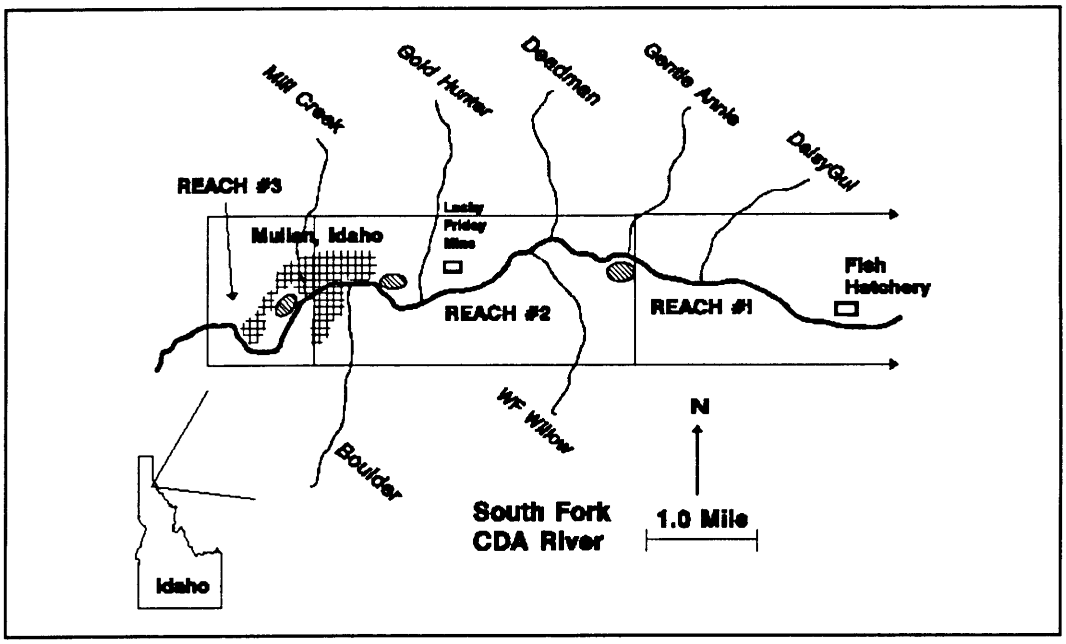

Figure 9 - Identification of river reaches in the sampling area.

Percent Contribution

Percent contribution of metals to the South Fork from point and nonpoint pollution sources were calculated for high and low flow regimes. The purpose of this calculation is to determine the relative proportions of metal in the river from point and nonpoint sources. This involves computing the percentage of mean daily river load at station #8 attributed to various pollution sources (point and nonpoint). Table 6 summarizes the percent contribution of total and dissolved metals from point source stations #2, #4, #6 and #7 and from nonpoint source loading within reach 1, reach 2 and reach 3. Cumulative nonpoint source contributions from headwaters to station #8 are also listed in table 6.

Cadmium

Nonpoint source additions of cadmium were the largest contributors of cadmium at river station #8 and accounted for 94.5% to 97.4%. Approximately 20% to 30% of the cadmium load at #8 entered the river from reach 1 (above reference station #1). Nonpoint sources within reach 2 accounted for 7% to 16% of the load at #8. The largest nonpoint loading occurred in reach 3, accounting for approximately 52% to 65% at #8.

Point sources were generally less than 1.5% at #8, although station #6 (pond 001) accounted for 3% of the load at #8. Point source additions of cadmium are small considering daily cadmium loads for various time regimes at station #8 were less than 0.25 kilograms/day. Figures 8 and 9 provide graphical illustrations of percent contributions of dissolved and total cadmium sources at high and low flows.

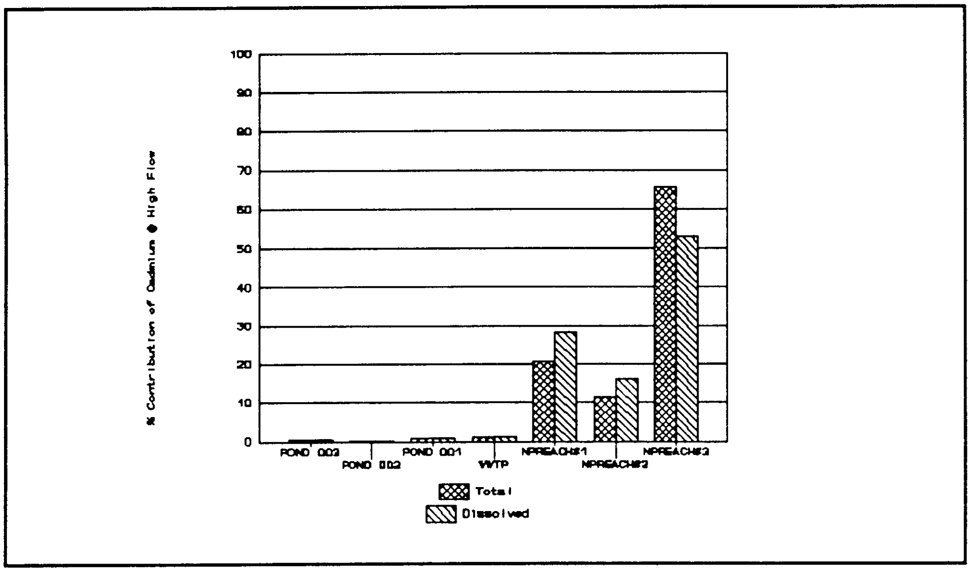

Figure 10 - Percent contribution of cadmium to river load at high flow.

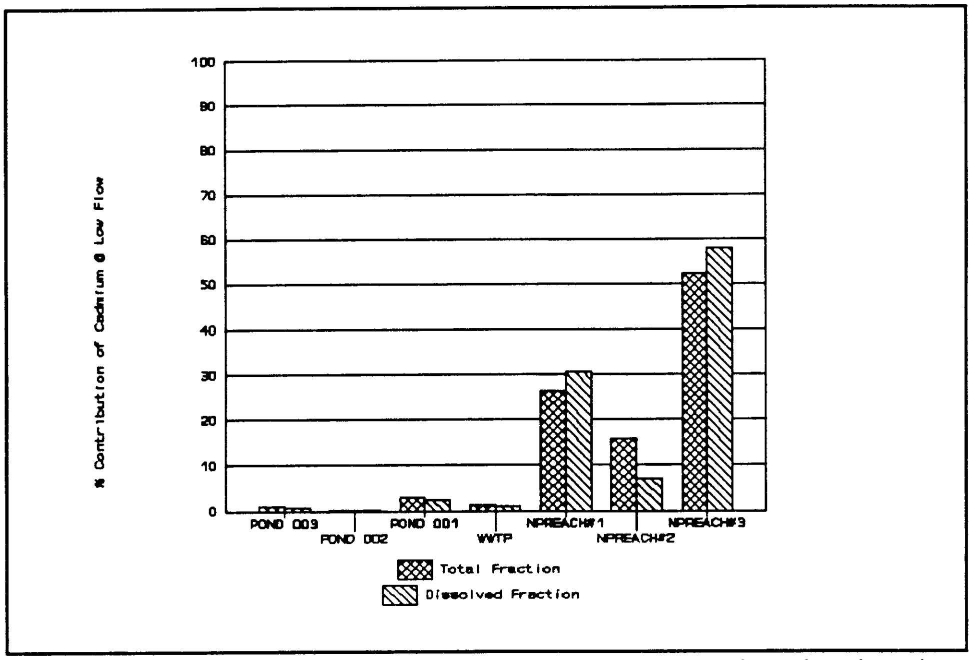

Figure 11 - Percent contribution of cadmium to river load at low flow.

Copper

Total and dissolved copper loading at station #8 was rather modest, amounting to 2.52 kgs/day at high flow and 0.748 kgs/day at low flow.

Nonpoint source additions were the primary source of copper accounting for approximately 93% to 97% of the load at station #8. The majority of the nonpoint source copper loading of occurred in the watershed above reference station #1 and within reach 3 (between #5 and #8).

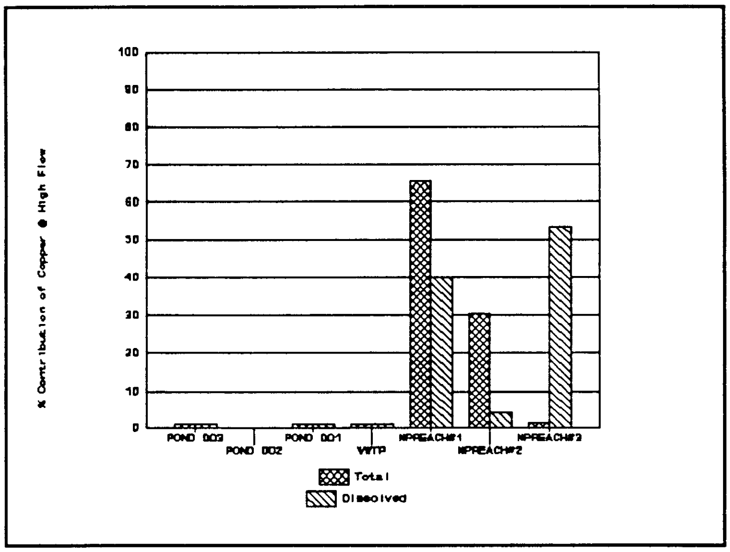

Figure 12 - Percent contribution of copper to river load at high flow.

Percent contributions from point sources were generally less than 2.4% with the highest point source daily load at high flow (0.025 kgs/day) coming from station #6 (pond 001). Table 6 lists percent contributions of metals from pollution sources. Table 5 lists corresponding daily loads. Figures 10 and 11 show percent contribution of total and dissolved copper at high and low flow.

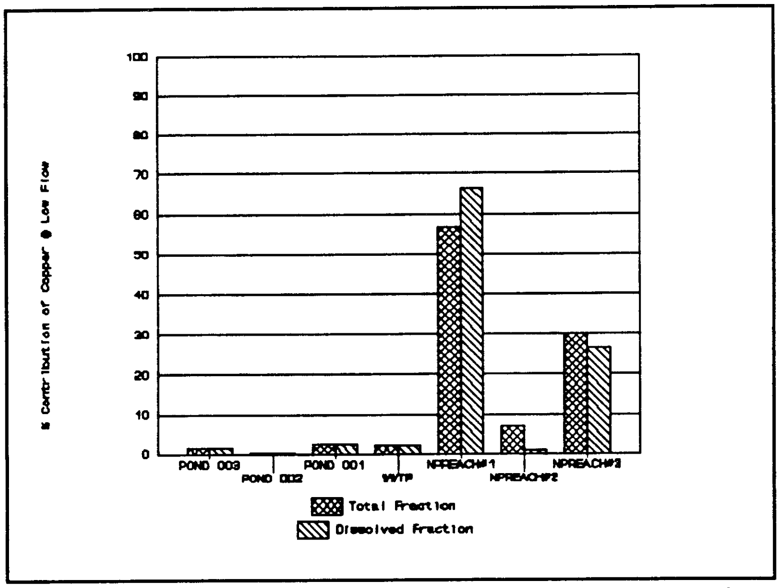

Figure 13 - Percent contribution of copper to river load at low flow.

Lead

Lead load in the South Fork is modest compared to other stream reaches in the watershed. Mean daily loading of total lead at high and low flow was 4.6 kgs/day and 0.95 kgs/day respectively. Daily loading of dissolved lead was 1.3 kgs/day (high flow) and 0.56 kgs/day (low flow). Figures 12 and 13 show percent contributions to river load from various pollution sources. Table 6 lists the calculated percentages and table 5 lists corresponding daily loads.

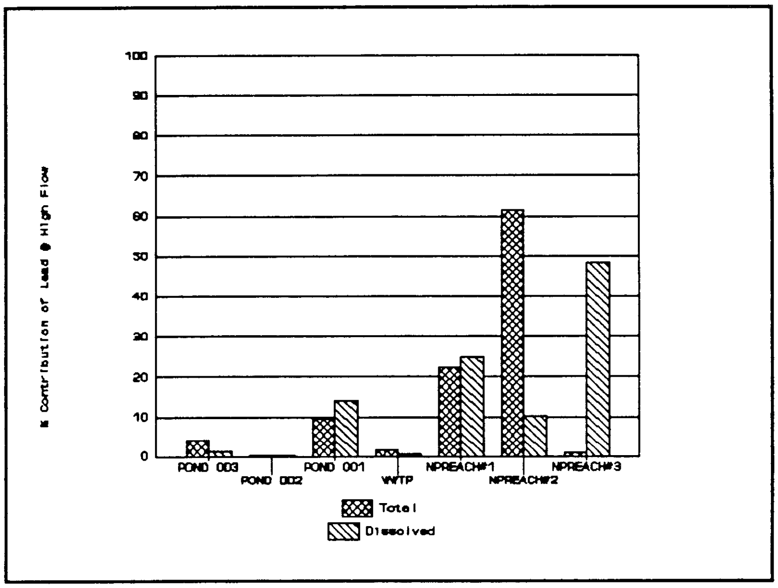

Figure 14 - Percent contribution of lead to river load at high flow.

Lead loading at high flow, to the South Fork above station #8 was largely from nonpoint sources (83%-85%). Lead loading from nonpoint sources at low flow was smaller ranging between 50% and 64%. Nonpoint pollution above reference station #1 accounted for between 15% and 25% of the river load at #8. The data indicates a large nonpoint total lead load at high flow between stations #1 and #5, accounting for approximately 61% (3 kgs/day) of the load at #8. Nonpoint additions within reach 3 located between stations #5 and #8, contributed the most dissolved lead to the river at #8 than all other sources, approximately 48% at high flow and 40% at low flow.

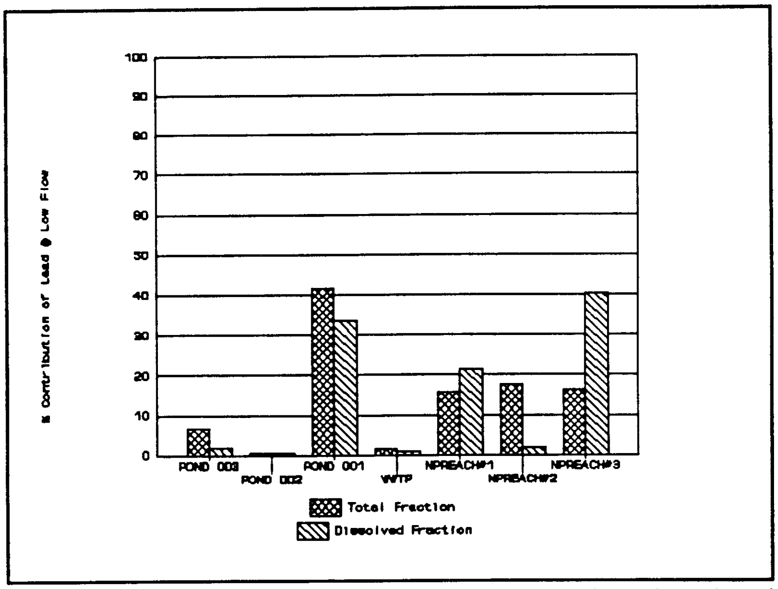

Figure 15 - Percent contribution of lead to river load at low flow.

Percent contribution of lead to the South Fork from point sources was largest of all metals studied. The largest point source load was measured at station #6 (pond 001). Pond 001 accounted for about 10% of the total lead load at high flow and 41% (0.4 kgs/day) at low flow. In regard to dissolved lead, pond 001 contributed 14% at high flow and 33.5% at low flow. Station #2 (pond 003) accounted for 4% the river load at #8 and about 7% at low flow. These data indicate lead loading from Hecla Pond 003 and Pond 001 account for a significant portion (appr. 1/3) at station #8. Lead loading from intermitted pond 002 (station #4) and the municipal waste water treatment plant (station #7) was small (<2%).

Zinc

Figures 14 and 15 show percent contribution of zinc from each source. Daily zinc loading in the South Fork was high, approximately 32 kgs/day 12 kgs/day at low flow of total zinc. Zinc load is largely in the dissolved form. Approximately 19 kgs/day of dissolved zinc at high flow and 11 kgs/day of dissolved zinc at low flow were estimated during the sampling period.

Nonpoint additions were by far the major contributor to the river Nonpoint pollution accounted for approximately 95% of the load at station #8. The majority of the nonpoint loading to the river occurred in reach 3 between stations #5 and #8. Zinc contribution from pond 003 (station #2) and pond 002 (station #4) were less than 1%. Contributions from pond 001 (station #6) and station #7 (WWTP) were less than 3 % of the load at station #8.

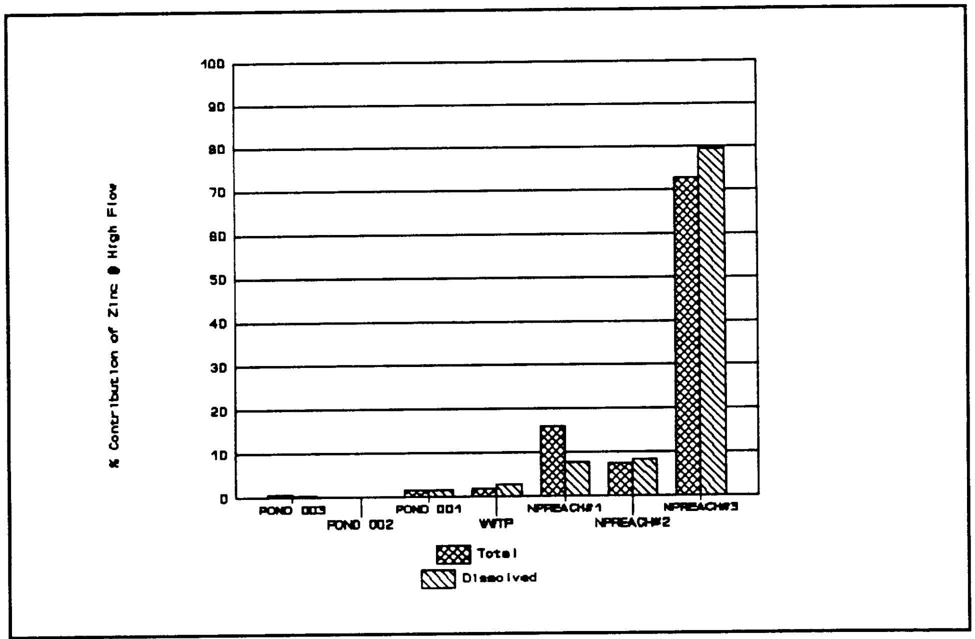

Figure 16 - Percent contribution of zinc to river load at high flow.

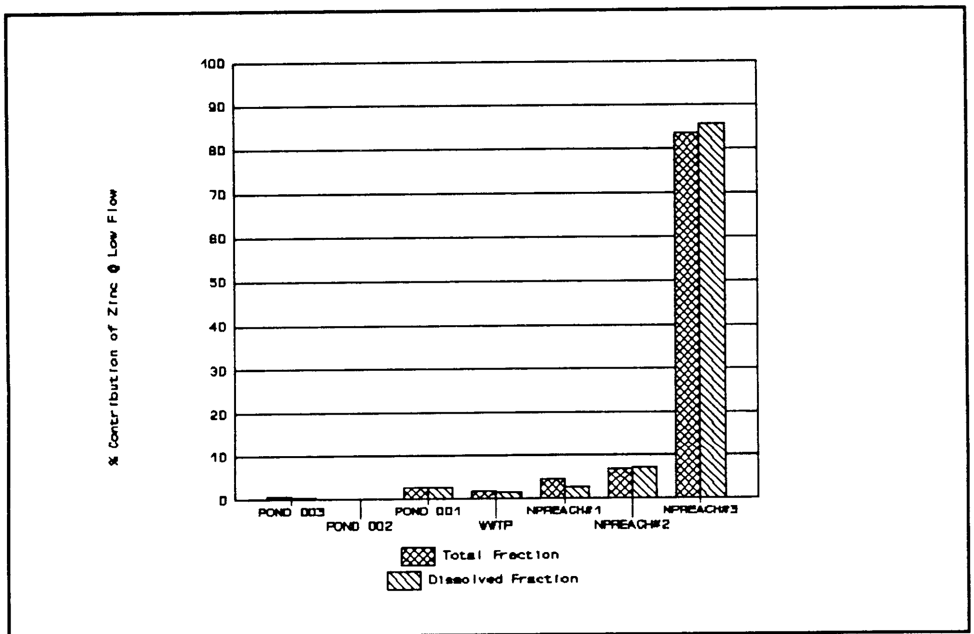

Figure 17 - Percent contribution of zinc to river load at low flow.

Table 7 - Percent Contribution of Metals to South Fork Coeur d'Alene River from Point and Nonpoint Sources

Point Source	Cadmium High Flow	Cadmium Low Flow	Copper High Flow	Copper Low Flow	Lead High Flow	Lead Low Flow	Zinc High Flow	Zinc Low Flow
			Total Fraction (%)					
Pond 003	0.4	1.0	0.9	1.7	4.0	6.8	0.5	0.6
Pond 002	0.1	0.2	0.0	0.1	0.2	0.5	0.1	0.1
Pond 001	0.9	3.0	1.0	2.4	9.6	41.5	1.4	2.7
WWTP	1.2	1.3	1.0	2.1	1.7	1.6	2.0	1.7
Nonpoint	97.3	94.5	97.1	93.7	84.5	49.6	96.0	94.9
NP(REACH#1)	20.5	26.5	65.5	56.6	22.2	15.7	16.1	4.5
NP(REACH#2)	11.4	15.8	30.4	7.0	61.4	17.6	7.5	6.9
NP(REACH#3)	65.5	52.2	1.2	30.2	1.0	16.4	72.4	83.5
			Dissolved Fraction (%)					
Pond 003	0.4	0.8	0.9	1.7	1.3	1.9	0.4	0.3
Pond 002	0.1	0.2	0.1	0.1	0.4	0.5	0.1	0.1
Pond 001	0.9	2.5	0.8	2.4	14.1	33.5	1.6	2.6
WWTP	1.2	1.1	1.1	2.1	0.6	0.8	2.8	1.6
NONPOINT	97.4	95.5	97.1	93.7	83.5	63.3	95.1	95.4
NP(REACH#1)	28.3	30.6	39.9	56.6	25.0	21.5	7.6	2.6
NP(REACH#2)	16.0	6.9	3.9	7.0	10.3	1.7	8.2	7.1
NP(REACH#3)	53.1	58.0	53.3	30.2	48.3	40.1	79.2	85.6

Field Parameters

Dissolved oxygen, temperature and pH were monitored at river stations during the sampling period. All parameters were within accepted ranges in the Idaho Water Quality Standards and Waste Water Treatment Requirements (IDHW-DEQ 1992). Effluent discharge from point sources were monitored for pH violations during the sampling period. Point source discharge for each sampling station was within the accepted range of 6.5 - 9.0, with the exception of discharge at pond 001 on April 25, 1990. The measured pH was 5.6 on that date.

Conductivity was also measured at all sampling stations. Appendix 6 contains a complete listing of field data as well as hardness and alkalinity analysis results.

Benthic Macroinvertebrates

The University of Idaho sampled macroinvertebrates in February 1990 and August 1990 (Rabe 1991). Data was analyzed according to Rapid Bioassessment Protocols (Plafkin *et al.* 1989). Three replicate macroinvertebrate samples were collected at each river station. Macroinvertebrate samples were identified to at least genus. Figure 16 illustrates the percent abundance of five important orders.

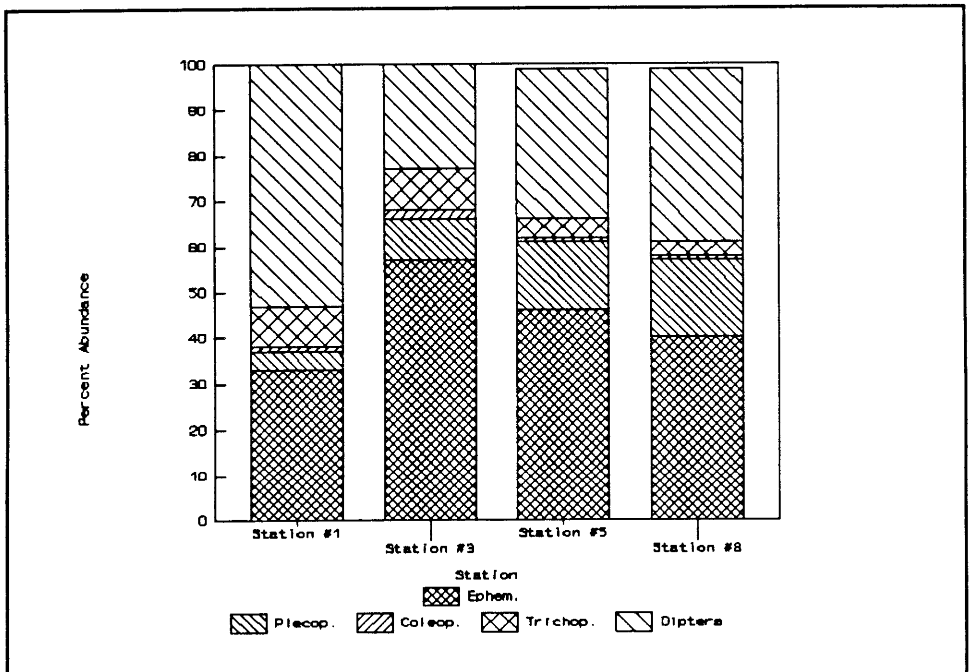

Figure 18 - Percent abundance of macroinvertebrate orders at river stations.

Macroinvertebrate bioassessment scores were developed from seven metrics at stations 3, 5, 8 and 8w (above WWTP), using station 1 as a reference site. Bioassessment scores were used to determine the level of impairment at each down stream site. Appendix 6 lists metrics and brief descriptions of each and the macroinvertebrate scores, percent of reference score and level of impairment for each sampling period. The metrics examined include the following:

Taxa Richness - measurement of how many taxa are present in the sample. More taxa usually reflect a healthier community.

Hilsenhoff Biotic Index - measurement of species sensitivity to pollutants.

Ratio of Scrappers to Collector Filterers - high counts of collector-filterers indicate a switch from periphyton food source such as diatoms to fine particulate organic matter (FPOM).

Ratio of Ephemeroptera, Plecoptera, Trichoptera (EPT) and Chironomid Abundances - streams which are represented well by EPT groups are usually considered less impacted than a stream which has high densities of chironomids.

Percent Contribution of Dominant Group - a community dominated by few species usually indicates environmental stress within the community.

EPT Index - the number of taxa within these three groups increase in streams with high biotic indexes. The three orders are considered to be the most sensitive to impact.

Community Similarity Indicies - using reference communities from one or more reference streams, similarity indicies are used to compare streams which have been impacted to a stream which has not been impacted.

For the February sampling, the metrics at station 1 were high enough to justify its use as a reference site. Analysis of the February 1990 bioassessment scores placed station 5 close to the moderately impaired category and stations 3 and 8 in the slightly impaired ranking. Tables 8, 9 and 10 list the metric values, metric scores and the percent of reference for each sampling station in February 1990.

The six out of the seven metrics examined for each station were held at equal weight. Percent dominant taxon was given the least weight. The index of community integrity (ICI) at station 8 was 30. The ICI at station 8 was 75 percent of reference station 1. Comparision between station 1 and station 8 places station 8 in the high end of the slighty impaired category. Taxa richness and EPT index were lower at station 8 compared to station 1. Taxa richness and EPT index indicate possible environmental stress between stations 1 and 8. However, the Hilsenoff biotic index (HBI) was lower at station 8 compared to station 1. The HBI for the February 1990 data indicates the collective tolorance of the taxa present at station 8 is not less than that of the reference.

Table 8 - Metric values for stations on the South Fork of the Coeur d' Alene River - February 1990.

Metric	Station # 1	# 3	# 5	# 8
Taxa Richness	36.0	25.0	14.0	25.0
Hilsenhoff's Biotic Index	4.6	4.2	3.9	4.2
Scrspers / Filters	0.5	2.0	1.0	3.2
% Dominate Taxon	25.0	48.0	40.0	31.0
EPT / Chironomids	1.4	3.2	2.7	1.6
EPT Index	23.0	15.0	8.0	16.0
Community Loss Index	0	0.56	1.7	0.76

* Station #1 used as a reference.

Table 9 - % Comparision of metrics with reference station - February 1990.

Metric	Station # 1	# 3	# 5	# 8
Taxa Richness	100	69	39	69
Hilsenhoff's Biotic Index	100	109	117	110
Scrspers / Filters	100	400	200	650
% Dominate Taxon	25	48	40	31
EPT / Chironomids	100	226	190	114
EPT Index	100	65	35	70
Community Loss Index	-	-	-	-

* All table values from Plafkin et al. Rapid Bioassessment Protocols (1989).

Table 10 - Bioassessment score of stations on South Fork of the Coeur d' Alene River - February 1990.

	Station Score			
Metric	# 1	# 3	# 5	# 8
Taxa Richness	6.0	4.0	0	4.0
Hilsenhoff's Biotic Index	6.0	6.0	6.0	6.0
Scrspers / Filters	6.0	6.0	6.0	6.0
% Dominate Taxon	4.0	0	2.0	2.0
EPT / Chironomids	6.0	6.0	6.0	6.0
EPT Index	6.0	0	0	2.0
Community Loss Index	6.0	4.0	2.0	4.0
TOTAL:	40.0	26.0	22.0	30.0
% OF REFERENCE SCORE:	100.0	65.0	55.0	75.0

Analysis Of Bioassessment Scores

>83% .... Unimpaired
54-79% .... Sightly Impaired
21-50% .... Moderatly Impaired
<17% .... Severly Impaired

Analysis of the August 1990 bioassessment scores placed stations 3 and 5 in the unimpaired category and station 8 in the slightly impaired ranking if compared to station 1. However, metrics at station 1 were generally lower than those representing stations 3 and 5 making station 1 an invalid reference site. Tables 11, 12 and 13 show the metric analysis for the August 1990 data. The metrics used for data analysis were generally lower at station 8 than at station 1. This indicates possible environmental stress at station 8.

In general, the macroinvertebrate metrics, especially taxa richness, percent dominant taxon and EPT index, indicate a reduction in in community diversity and replacement of sensitive taxa when compared to the reference station. The change in macroinvertebrate communities at down stream sample sites may be largely attributed to increased metals toxicity, since habitat conditions at each site are relatively constant. Hoiland (1992) found moderate correlations (r_2=0.40-0.58) of zinc concentrations with the above mentioned metrics at various sample site in the upper South Fork drainage. As mentioned earilier, trace heavy metal contributions to the river within study site are primarily from nonpoint sources (> 95% Zn). Other factors, including point and nonpoint source nutrient loading, urban runoff, point source metals discharges and channelization may also contibute to changes in community stucture between station 1 and station 8.

Table 14 show density fluctuations between the February and August sampling events. Macroinvertebrate densities at stations 1 and 8 fluctuated drastically, while densities were relatively stable at stations 3 and 5.

Table 11 - Metric values for stations on the South Fork of the Coeur d' Alene River - August 14, 1990.

	Station				
Metric	# 1	# 3	# 5	# 8	# 8W
Taxa Richness	12.0	17.0	12.0	7.0	6.0
Hilsenhoff's Biotic Index	4.1	5.0	3.4	4.3	5.1
Scrapers / Filters	0	0	0	0.25	0
EPT / Chironomids	3.3	16.0	13.2	2.1	0.2
% Dominate Taxon	23.0	68.0	59.0	37.0	64.0
EPT Index	8.0	13.0	9.0	4.0	4.0
Community Loss Index	0	0.18	0.33	1.0	1.2

* All table values from Plafkin et al. Rapid Bioassessment Protocols (1989).

Table 12 - % comparision of metrics with reference station August 14, 1990.

	Station				
Metric	# 1	# 3	# 5	# 8	# 8W
Taxa Richness	100	140	100	58	50
Hilsenhoff's Biotic Index	100	81	120	95	81
Scrspers / Filters	-	-	-	-	-
EPT / Chironomids	100	485	400	65	15
% Dominant Taxon	23	68	59	37	64
EPT Index	100	162	113	50	50

Table 13 - Bioassessment score of stations on the South Fork of the Coeur d'Alene River - August 14, 1990.

	Station Score				
Metric	# 1	# 3	# 5	# 8	# 8W
Taxa Richness	6	6	6	2	2
Hilsenhoff's Biotic Index	6	4	6	6	4
Scrapers / Filters	-	-	-	-	-
EPT / Chironomids	6	6	6	4	0
% Doninant Taxon	4	0	0	2	0
EPT Index	6	6	6	0	0
Community Loss Index	6	6	6	4	4
Total:	34	28	30	18	10
% Of Reference Score:	100	82	88	53	29

Analysis of Bioassessment Scores

>83% .... Unimpaired
54-79% .... Slightly Impaired
21-50% .... Moderately Impaired
<17% .... Severly Impaired

* All table values from Plafkin et al. Rapid Bioassessment Protocols (1989).

Table 14 - Density of macroinvertebrates in upper South fork of the Coeur d' Alene River drainage February - August 1990.

Station	February	August
# 1	1500	150
# 3	733	750
# 5	360	260
# 8	1180	82
# 8W	-----	80

Macroinvertebrates were sampled in August 1992 at eight sites on the South Fork Coeur d'Alene River (Clark 1992). Family richness at the control station below Shoshone Park was compared to family richness at a down stream station above Canyon Creek. The data shows a decrease in the number of families in the Order Ephemeroptera and an increase in the number of Diptera families (figure 17). Family richness of the remaining Orders is relatively constant. Simarlarly to the 1990 macroinvertebrate data, this analysis indicates a minor shift in the macroinvertebrate community structure between Shoshone Park and Canyon Creek, that could be attributed to upstream point source pollution loading, nonpoint source pollution loading and/or other environmental factors. Figure 18 shows abundance estimates at stations throughout the South Fork.

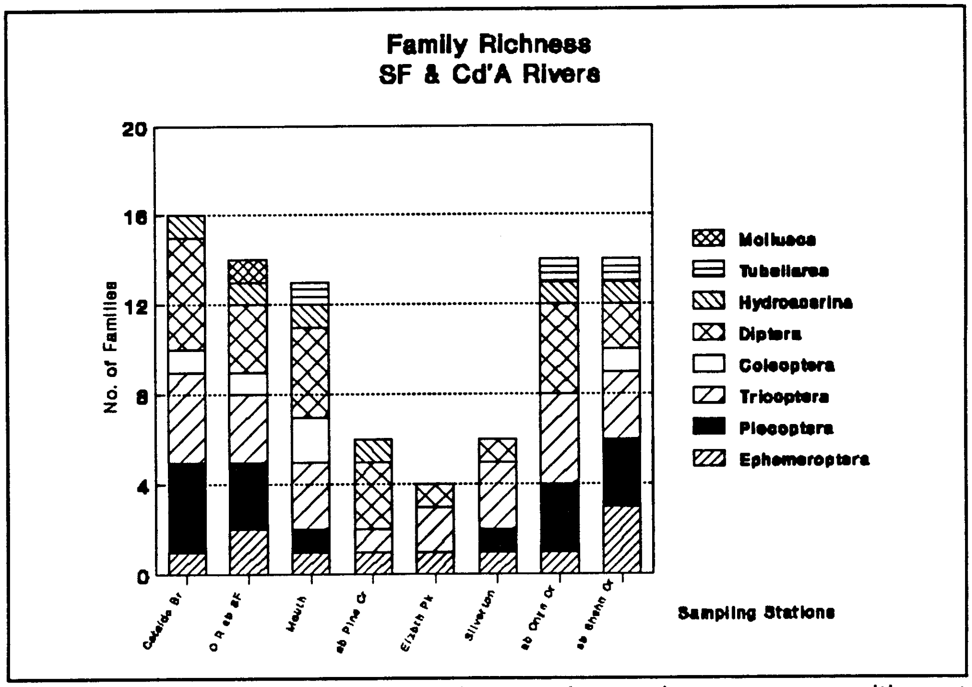

Figure 19 - Family richness of macroinvertebrate communities at sampling stations in the South Fork Coeur d'Alene River.

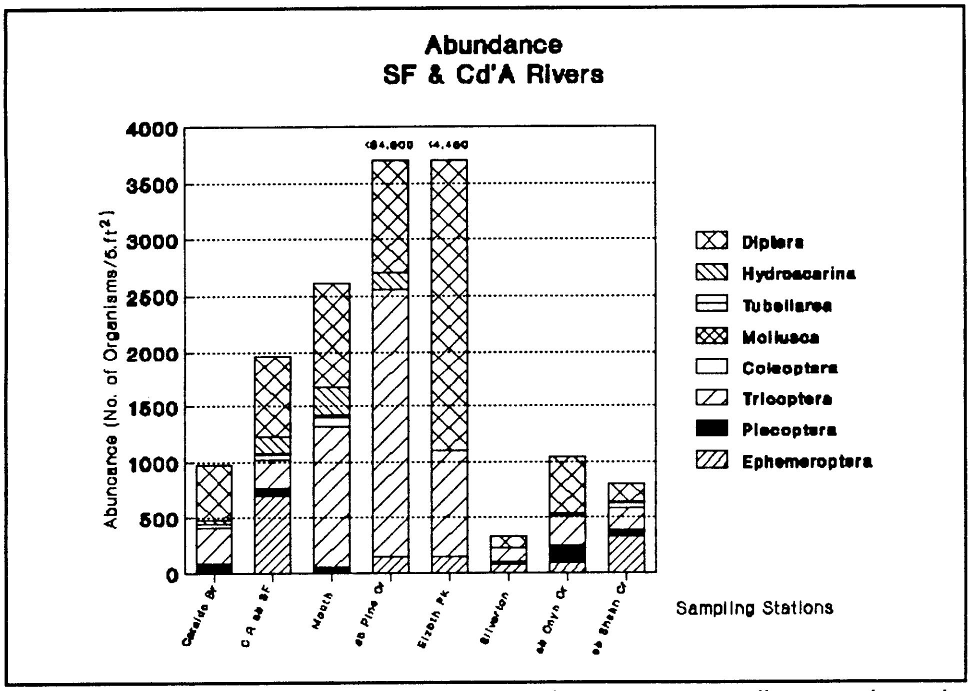

Figure 20 - Macroinvertebrate abundance at sampling stations in the South Fork Coeur d'Alene River.

Habitat Assessment

Stream habitat was assessed according to Rapid Bioassessment Protocols (Plafkin *et al.* 1989) in July 1990. Nine habitat parameters were used to evaluate the stream at stations 1, 3, 5 and 8. The habitat parameters were scored and totals for each station were compared to the reference site (station 1). Each site was placed in an assessment category based on percent of comparability to the reference site. Table 15 lists individual parameter scores, total scores and percent of comparability to reference.

In summary, physical habitat at station 8 was comparable to station 1. At station 3 and 5, habitat scores indicated support when compared to station 1. In general, fisheries habitat is similar at each river station. Stream side cover, embeddedness and bank vegetation at station 8 were slighty lower than these parameters at the reference station.

Table 15 - Habitat scores at river stations.

Habitat Parameter	**Rating Range**	**Station #1**	**#3**	**#5**	**#8**
1. Bottom Substrate	(0-20)	20	20	20	20
2. Embeddedness	(0-20)	19	17	20	17
3. Velocity/Depth	(0-20)	15	10	10	15
4. Channel Alteration	(0-15)	8	8	8	8
5. Scouring and Deposition	(0-15)	15	14	15	15
6. Pool/Riffle Ratio	(0-15)	11	6	8	11
7. Bank Stability	(0-10)	10	9	9	9
8. Bank Vegetation	(0-10)	10	10	7	9
9. Stream Side Cover	(0-10)	9	8	5	2
Total Score		117	102	102	106
% of Reference		100	87	87	91

Fish Survey

IDEQ identified fish species and measured individuals at four stations (1, 3, 5 and 8) on August 27 and 28 1990. The original intent of the fish survey was to determine the level of impairment (if any) of the fisheries below each point source outfall. This was to be accomplished using Rapid Bioassessment Protocol V, as outlined in (Plafkin *et al.* 1989). Equipment failures (battery failure) prevented sampling crews from acquiring two electroshocking passes at stations 5 and 8. Due to lack of sufficient data, population estimates could not be determined. In addition, regional scoring criteria for use with Rapid Bioassessment Protocols V metrics were not developed and IBI scores were not calculated.

Catch per unit effort was calculated for each species at each sampling station. This calculation indicates the number of fish captured for each minute of shocking time and serves to normalize one pass captures at each station. Appendix 7 lists the number of fish captured for each size range and species, total number of individuals for each species, catch per unit time and percent of reference.

West slope Cutthroat and Shorthead Sculpin were the native species captured during the survey. In regards to Cutthroat, catch per unit effort at station 8 was 96% of the reference condition (station 1). At stations 3 and 5 catch per unit effort was approximately half that of the reference condition. All age classes were represented. In regards to sculpin, catch per unit effort at stations 3 and 5 was 1.5 to 2 times higher than the reference site, and approximately half that of the reference site.

Other species captured included: Rainbow Trout, Brook Trout, and Kokanee. These species are all introduced to the system and appeared to have variable population densities throughout the study site.

Conclusions and Recommendations

Three objectives of this study are to: a) determine the metals loading in the South Fork Coeur d'Alene River above the Morning bridge and compare the relative metals contributions from point and nonpoint sources; b) determine the effect of pollutants on cold water biota by comparing instream metals concentrations to water quality criteria for fresh water organisms and by determining the existence and status of the biota; and c) determine the relevance of the current segment boundary between segments PB-130s and PB 140s (as of 1992) by comparing water quality and biota between segments.

Metals Loading and Sources

The trend monitoring design provides an adequate estimate of metals loading to the South Fork from point and nonpoint pollution sources. Nine data points at high flow and eleven data points at low flow provide estimates of average instream concentrations and average daily load for various flow regimes. The study also provides estimates of daily metals load leaving the South Fork above the Morning bridge. The metals load at the Morning District Bridge was modest in comparison to other high loading reaches in the South Fork drainage. High flow (March - June) daily loads at station #8 (lower station) were 0.24 kgs/day cadmium, 2.52 kgs/day copper, 4.80 kgs/day lead and 32.17 kgs/day zinc. Low flow (July - February) daily loads were 0.06 kgs/day cadmium, 0.75 kgs/day copper, 0.95 kgs/day lead and 12.35 kgs/day zinc (data represents loads at station #8). Daily loads at other sampling stations as well as nonpoint source loads are found in table 5.

Nonpoint sources appeared to be the major contributor of metal to the river above station #8. Cadmium, copper and zinc loads were attributed primarily (94% - 97%) to nonpoint sources. Lead load is largely from nonpoint sources however, a significant portion (14% tot. lead @ high flow and 48% tot. lead @ low flow) of the load in the river was delivered from Hecla tailings pond outfalls (combined outfall contributions). Tailings pond 001 (station #6) appeared to be the least efficient treatment pond in 1990. Reduction of effluent metals load from pond 001 would significantly reduce the combined point source metals load.

According to the 1990 data, nonpoint sources at high flow accounted for 97% of the total cadmium, 97% of the total copper, 84.5% of the total lead and 96% of the total zinc. Nonpoint sources at low flow accounted for 94.5% total cadmium, 94% total copper, 50% total lead and 95% total zinc. Nonpoint sources of dissolved metals were similar to that of total metals but varied somewhat.

Instream Concentrations and Water Quality Criteria

Average instream dissolved cadmium concentrations were below chronic exposure limits at every river station in the sampling area. There appeared to be an increase in dissolved cadmium concentrations between station #5 and #8 (reach 3) which was primarily attributed to nonpoint sources. Reach 3 flows through Mullan. Dissolved copper concentrations did not increase through the length of the study area and did not exceed chronic exposure criteria.

Instream dissolved lead concentrations were above chronic exposure criteria at all river stations. Even dissolved lead concentrations upstream of reference station #1 exceeded chronic exposure criteria for lead. There was a large increase in the dissolved lead fraction between stations #5 and #8 while the total fraction did not increase. Increasing lead concentrations during low flow between station #5 and #8 could be attributed to nonpoint loading in reach 3 as well as loading from tailings pond 001 outfall. Nonpoint dissolved metal load in reach 3 was larger than the pond 001 metal load at high flow (Figure 12) although, low flow dissolved nonpoint metal load and pond 001 outfall load were in similar proportions (Figure 13). Therefore, the large increase in dissolved lead concentration at station #8 during low flow was influence by pond 001 (appr. 33%) and nonpoint sources within reach 3 (appr. 40%).

Instream dissolved zinc concentrations exceeded chronic exposure criteria at station #8 but did not exceed at upstream river stations. A large increase in zinc concentration was measured between #5 and #8. Percent contribution estimates indicate increased concentration between #5 and #8 was attributed to nonpoint source loading within reach 3.

In regard to dissolved metal concentrations, the data do not indicate any violations of cadmium and lead acute exposure criteria. However, copper occasionally exceeded acute copper criteria and zinc readily exceeded acute exposure criteria. Tables 1 through 4 list concentrations of each metal on all sampling dates. It should be noted that acute criteria are based on a one hour average concentration. Lack of a tailored monitoring scheme promoting replication over a one hour period, prevents statistical validation of any acute exposure criteria violation. However, it is valid to assume dissolved zinc concentrations consistently exceed acute criteria based on individual sample concentrations during the sample period.

Segment Boundary

Prior to 1992 the segment boundary separating PB-140s and PB-130s was thought to be located at the upstream perimeter of the Mullan town site. The segment boundary location was clarified in 1992 by Senate Concurrent Resolution 133. Current interpretation of the PB-140s/PB130s segment boundary places the boundary above the mining impacts (appr. 3.0 stream miles upstream at Daisy Gulch). Segment PB-130s is protected for the following uses: domestic water supply; agricultural water supply; cold water biota; salmonid spawning; and primary and secondary contact recreation (16.01.02110,01.k). PB-140s is protected for agricultural water supply and secondary contact recreation with cold water biota and primary contact recreation designated as protected for future use (IDAPA 16.01.02110,01.v). Biological data collected in this study do not support the placement of the current PB-140s/PB-130s segment boundary at Daisy Gulch or the

Mullan town site location.

Macroinvertebrate sampling at stations #1, #3, #5 and #8 indicated existence of cold water biota at every site (i.e. presence of EPT orders). The data showed minor shifts in macroinvertebrate diversities from station #1 down to station #8. Percent abundance of the order Trichoptera decreased between station #1 and #8, however the sensitive order Plecoptera increased from station #1 down to #8. The observed shifts in macroinvertebrate communities through the length of the study area could be attributed to increasing metals concentrations from nonpoint and/or point sources, increasing nutrient concentrations, minor habitat changes, food source changes or a change in stream size. In terms of macroinvertebrates, cold water biota appears to be in full support with slight impairment of the use possible at station #8.

Fish sampling at stations #1, #3, #5 and #8 also indicated existence of cold water biota (i.e. presence of native Cutthroat trout). The status of the fisheries within the study reach could not be conclusively determined given the available field information. However, the number of wild Cutthroat trout captured per unit effort during one electrofishing pass at stations #1 (reference) and station #8 were comparable. More Cutthroat trout were captured down stream at station #8. In addition, the available electrofishing information suggests a similar age class distribution between station #1 and station #8.

Use attainability information conducted by IDEQ (IDEQ 1993) in the South Fork below Mullan showed that primary and secondary contact recreation, cold water biota and salmonid spawning are attainable beneficial uses. Furthermore, these attainable uses were found to be existing in the South Fork below Mullan and above Canyon Creek. The Idaho Water Quality Standards (IDAPA 16.01.02050,02) mandate the protection of waters of the state for "appropriate beneficial uses". Appropriate beneficial uses, as used in IDAPA 16.01.02050,02, are defined in IDAPA 16.01.02003,01 and include all existing uses of a water body, and all uses which are attainable in the future (attainable uses). Cold water biota and salmonid spawning are existing uses in segment PB-140s and are currently protected under section 16.0102050,02 of the Idaho Water Quality Standards.

Section 101 (a) (2) of the Clean Water Act states: "it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides recreation in and on the water be achieved by July 1, 1983". All sampling stations were located within segment PB-140s which has lower level use designations as outlined in. The data do not support the placement of the current segment boundary between PB-140s and PB-130s at Daisy Gulch, because the beneficial uses present at all sampling stations include cold water biota. In addition, cold water biota was found to exist (i.e. presence of native Cutthroat trout) in the South Fork just above Canyon Creek (Corsi 1992). Since cold water biota is an existing use (40 CFR 131.3(e)) in the South Fork above Canyon Creek and is an attainable use down to the mouth, the Clean Water Act (section 101 (a) (2)) sets the goal of protection of cold water biota in the river from the mouth to the headwaters.

Existing uses in the South Fork are further protected by state antidegradation regulation (IDAPA 16.01.02050,01.) which states "The existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected".

304 (l) listing

In 1990 EPA decided to include segment PB-130s on the section 304 (l) list. This decision preceded the 1992 segment boundary clarification. Under section 304 (l) of the 1987 Water Quality Act, stream segments with impaired beneficial uses that receive point source discharges of toxic pollutants, can be included on the State 304 (l) list. This listing can facilitate development of individual control strategies to bring a water body into compliance.

The data generated in this study do not conclusively indicate an impairment of beneficial uses with regard to cold water biota in the South Fork between Mullan and Daisy Gulch (station 1 and 3). Furthermore, the water quality data do not indicate a substantial contribution of heavy metals from point sources within that reach. While there appears to be shifts in the benthic community structure within the study area, the current study design does not adequetly separate effects from point source discharge from other environmental factors (non-point source metals loading). Adverse impact on aquatic biota from point source discharges is necessary for 304 (l) to apply. According to current information, section 304 (l) does not appear to apply to the South Fork between Mullan and Daisy Gulch.

In conclusion, this study has documented support of cold water biota in reaches of the South Fork Coeur d'Alene River where accepted water quality criteria for lead and zinc (dissolved fractions) are exceeded. This can be attributed to either: 1) overly conservative water quality criteria for lead and zinc or 2) adaptation of biological systems requiring study beyond the scope of this report.

Recent information demonstrates the existence of cold water biota (fish and macroinvertebrates) in stream segment PB-140s of the South Fork. Therefor the water quality goal of the South Fork in PB-140s should include protection of cold water biota where the use is found to exist. Furthermore, the South Fork of the Coeur d'Alene River should be assigned water quality protection necessary to support all appropriate beneficial uses, which include existing and attainable uses.

Recommendations

The protected beneficial uses of the South Fork should include cold water biota at all locations in the study area as mandated by State and Federal policies described in this report. Minimum water quality criteria necessary to protect those uses should be adhered to.

A site specific study to determine accurate instream toxic concentration limits for the South Fork in the study area is necessary. Accurate and reliable site specific criteria will protect aquatic organisms as well as economic interests. Such site specific studies designs should be statistically based and should utilize endigenous fish and macroinvertebrate species in natural waters found at the site.

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APPENDIX 1 - Sample Station Locations and Storet Numbers.

SURVEY NAME: SF COEUR D'ALENE

116 = 891608 HUC = 17010302 DATE: 02 Jan 91

STORET #	Station	DESCRIPTION	LATITUDE	LONGITUDE
2000378	1	AB #3 Tailings Pnd BL Daisy Gulch	47°28'10"	115°44'44"
2000379	2	#3 Tailings Pnd BL Daisy Gulch	47°28'16"	115°45'33"
2000380	3	AB #2 Tailings Pond Discharge @ I-90 Bridge	47°28'04"	115°47'06"
2000381	4	#2 Tailings Pond Discharge ID-000017-5-002	47°28'07"	115°47'17"
2000382	5	AB #1 Tailings Pond Dis-charge @ I-90 Mullan	47°28'00"	115°48'00"
2000383	6	#1 Tailings Pond Discharge ID-000017-5-001	47°27'49"	115°48'22"
2000384	7	Mullan WWT Discharge ID-002130-3-002	47°27'54"	115°48'37"
2000385	8	BL WWT Discharge @ Morning District I-90	47°27'54"	115°48'45"

APPENDIX 2 - Summary of Quality Assurance Results.

Summary Statistics for Precision (Duplicates) Data.

		X1	X2	MEAN	RANGE	R.RANGE (%)
Diss. Cd.	1	0.5	0.5	0.5	0	0.000
	2	0.5	0.5	0.5	0	0.000
	3	0.25	0.25	0.25	0	0.000
	4	0.6	0.25	0.425	0.35	82.353
	5	0.25	0.25	0.25	0	0.000
	6	0.25	0.25	0.25	0	0.000
	7	0.25	0.25	0.25	0	0.000
	8	0.5	0.6	0.55	0.1	18.182
	AVERAGE RELATIVE RANGE =					12.567
		X1	X2			
Diss. Cu.	1	5	5	5	0	0.000
	2	3	4	3.5	1	28.571
	3	7	1	4	6	150.000
	4	2	2	2	0	0.000
	5	1	1	1	0	0.000
	6	1	1	1	0	0.000
	7	1.5	1.5	1.5	0	0.000
	8	3	3	3	0	0.000
	AVERAGE RELATIVE RANGE =					22.321
		X1	X2			
Diss. Pb.	1	2.5	2.5	2.5	0	0.000
	2	2.7	2.5	2.6	0.2	7.692
	3	5	4	4.5	1	22.222
	4	3.4	3	3.2	0.4	12.500
	5	4.1	4.3	4.2	0.2	4.762
	6	3.8	1.25	2.525	2.55	100.990
	7	7	1.5	4.25	5.5	129.412
	8	7	5	6	2	33.333
	AVERAGE RELATIVE RANGE =					38.864
		X1	X2			
Diss. Zn.	1	100	100	100	0	0.000
	2	143	144	143.5	1	0.697
	3	147	147	147	0	0.000
	4	45	46	45.5	1	2.198
	5	50	48	49	2	4.082
	6	55	54	54.5	1	1.835
	7	62	79	70.5	17	24.113
	8	97	99	98	2	2.041
	AVERAGE RELATIVE RANGE =					4.371

Summary of Percent Recovery (Accuracy) for Dissolved Metals.

	Diss.Cd.	Diss.Cu.	Diss.Pb.	Diss.Zn.
Percent Recovery	96	88	105	97
	99	103	109	96
	102	99	94	100
	113	98	103	97
	98	103	101	103
Sum =	508	491	512	493
Average Percent Recovery =	101.6	98.2	102.4	98.6
Standard Deviation =	6.02	5.49	4.96	2.58
Confidence Interval =	5.82	5.30	4.80	2.49

APPENDIX 3 - Regression Outputs of Stage Discharge Relationships at River Stations.

	Gaging Date	Stage Ht.	Measured Flow	Angle Coeff.	Corrected Flow	Log Stage	Log Correct Flow	Stage Discharge Regression Stage independent	
Station #1	01/10/90	8.1	87.78	0.95	83.391	0.908485	1.921119	Station #1 Regression Output:	
	02/07/90	8.88	16.14	1	16.14	0.948413	1.207904	Constant	12.75648
	04/18/90	7.64	155.73	0.95	147.9435	0.883093	2.170096	Std Err of Y Est	0.126914
	07/31/90	8.93	21.64	1	21.64	0.950851	1.335257	R Squared	0.925241
	04/25/91	7.70	127.94	1	127.94	0.886491	2.107006	No. of Observations	11
	05/14/91	7.55	150.01	0.95	142.5095	0.877947	2.153844	Degrees of Freedom	9
	06/06/91	7.79	120.11	1	120.11	0.891537	2.079579		
	07/15/91	8.88	43.01	1	43.01	0.948413	1.633569	X Coefficient(s)	-11.9893
	07/19/91	8.83	36.61	1	36.61	0.945961	1.5636	Std Err of Coef.	1.135993
	09/06/91	9.30	10.2	1	10.2	0.968483	1.0086		
	09/24/91	9.21	14.54	1	14.54	0.96426	1.162564		
Station #3	01/11/90	18.37	122.89	1	122.89	1.264109	2.089517	Station #3 Regression Output:	
	02/07/90	19.05	28.23	1	28.23	1.279895	1.450711	Constant	51.88622
	04/18/90	18.04	285.96	1	285.96	1.256237	2.456305	Std Err of Y Est	0.114667
	07/31/90	19.00	38.83	1	38.83	1.278754	1.589167	R Squared	0.929092
	04/25/91	18.17	169.57	1	169.57	1.259355	2.229349	No. of Observations	12
	05/14/91	18.00	243.45	1	243.45	1.255273	2.38641	Degrees of Freedom	10
	06/06/91	18.50	193.72	1	193.72	1.267172	2.287174		
	07/15/91	18.81	56.54	1	56.54	1.274389	1.752356	X Coefficient(s)	-39.3566
	07/15/91	18.81	68.18	1	68.18	1.274389	1.833657	Std Err of Coef.	3.438241
	07/19/91	18.81	57.01	1	57.01	1.274389	1.755951		
	09/06/91	19.20	22.59	1	22.59	1.283301	1.353916		
	09/24/91	19.15	19.23	1	19.23	1.282169	1.283979		

	Gaging Date	Stage Ht.	Measured Flow	Angle Coeff.	Corrected Flow	Log Stage	Log Correct Flow	Stage Discharge Regression Stage Independent	
Station #5	01/10/90	12.40	168.75	0.86	145.125	1.093422	2.161742	Station #5 Regression Output:	
	02/07/90	13.20	29.16	1	29.16	1.120574	1.464788	Constant	31.83209
	04/18/90	12.03	272.21	0.86	234.1006	1.080266	2.369403	Std Err of Y Est	0.126749
	07/31/90	13.10	44.42	1	44.42	1.117271	1.647579	R Squared	0.927855
	04/25/91	12.26	226.23	1	226.23	1.08849	2.35455	No. of Observations	11
	05/14/91	12.05	316.23	0.86	271.9578	1.080987	2.434502	Degrees of Freedom	9
	06/06/91	12.15	233.05	1	233.05	1.084576	2.367449		
	07/15/91	12.70	83.51	1	83.51	1.103804	1.921738	X Coefficient(s)	-27.1735
	07/19/91	12.76	62.29	1	62.29	1.105851	1.794418	Std Err of Coef.	2.525742
	09/06/91	13.15	19.82	1	19.82	1.118926	1.297104		
	09/24/91	13.04	19.22	1	19.22	1.115278	1.283753		
Station #8	01/10/90	15.96	158.03	1	158.03	1.203033	2.19874	Station #8 Regression Output:	
	02/07/90	17.17	42.58	1	42.58	1.23477	1.629206	Constant	31.75344
	04/11/90	16.22	188.81	1	188.81	1.210051	2.276025	Std Err of Y Est	0.086435
	07/31/90	17.03	43.56	1	43.56	1.231215	1.639088	R Squared	0.967219
	05/14/91	15.65	332.44	1	332.44	1.194514	2.521713	No. of Observations	9
	06/06/91	15.78	272.78	1	272.78	1.198107	2.435813	Degrees of Freedom	7
	07/15/91	16.70	78.75	1	78.75	1.222716	1.896251		
	09/06/91	17.30	26.5	1	26.5	1.238046	1.423246	X Coefficient(s)	-24.4649
	09/24/91	17.37	21.2	1	21.2	1.2398	1.326336	Std Err of Coef.	1.702336

APPENDIX 4 - ISCO Concentrations and Loads Measured at River Station #8.

Summary of Annual, High Flow, and Low Flow Total Metals Concentrations and Loads.
(estimates developed via ISCO sampling at Station #8, Morning District bridge)

DATE	FLOW (cfs)	TOTAL CD. (ppb)	TOTAL CD. (kgs/day)	TOTAL CU. (ppb)	TOTAL CU. (kgs/day)	TOTAL PB. (ppb)	TOTAL PB. (kgs/day)	TOTAL ZN. (ppb)	TOTAL ZN. (kgs/day)
08-Nov-89	37.14	1.50	0.14	10.00	0.91	29.00	2.63	190.00	17.26
11-Nov-89	149.97	3.00	1.10	30.00	11.01	150.00	55.04	510.00	187.12
27-Nov-89	67.37	1.90	0.31	20.00	3.30	19.00	3.13	120.00	19.78
23-Nov-89	47.40	1.00	0.12	10.00	1.16	35.00	4.06	90.00	10.44
04-Dec-89	48.79	1.20	0.14	31.00	3.70	150.00	17.90	180.00	21.48
08-Dec-89	83.74	0.60	0.12	17.00	3.48	14.00	2.87	230.00	47.12
21-Dec-89	42.24	3.20	0.33	21.00	2.17	10.00	1.03	80.00	8.27
20-Dec-89	40.47	2.90	0.29	25.00	2.47	10.00	0.99	120.00	11.88
03-Jan-90	33.61	6.30	0.52	27.00	2.22	21.00	1.73	150.00	12.33
07-Jan-90	55.58	2.20	0.30	5.00	0.68	47.00	6.39	280.00	38.07
08-Jan-90	71.23	3.50	0.61	1.50	0.26	65.00	11.33	180.00	31.37
09-Jan-90	100.04	9.50	2.33	23.00	5.63	277.00	67.80	34.00	8.32
10-Jan-90	212.88	25.00	13.02	11.00	5.73	68.00	35.41	240.00	124.99
11-Jan-90	119.66	0.90	0.26	1.50	0.44	7.00	2.05	140.00	40.99
12-Jan-90	94.27	3.10	0.71	1.50	0.35	4.00	0.92	160.00	36.90
15-Jan-90	62.44	2.40	0.37	16.00	2.44	14.00	2.14	160.00	24.44
18-Jan-90	52.45	2.40	0.31	9.00	1.15	4.00	0.51	180.00	23.10
13-Feb-90	39.89	14.30	1.40	5.00	0.49	20.00	1.95	148.00	14.44
18-Feb-90	34.30	6.10	0.51	3.00	0.25	14.00	1.17	71.00	5.96
01-Mar-90	36.09	2.90	0.26	5.00	0.44	20.00	1.77	177.00	15.63
06-Mar-90	42.24	2.10	0.22	5.00	0.52	54.00	5.58	189.00	19.53
12-Mar-90	44.74	1.90	0.21	1.50	0.16	13.00	1.42	167.00	18.28
11-Apr-90	119.66	1.00	0.29	4.00	1.17	26.00	7.61	79.00	23.13
20-Apr-90	233.44	1.70	0.97	13.00	7.42	100.00	57.11	329.00	187.89
23-Apr-90	240.74	5.10	3.00	8.00	4.71	50.00	29.45	146.00	85.99
02-May-90	84.99	0.70	0.15	7.00	1.46	16.00	3.33	112.00	23.29
03-May-90	84.99	1.20	0.25	1.50	0.31	13.00	2.70	65.00	13.52
04-May-90	94.27	1.50	0.35	6.00	1.38	35.00	8.07	94.00	21.68
05-May-90	132.93	2.40	0.78	22.00	7.15	119.00	38.70	345.00	112.19
06-May-90	244.49	1.70	1.02	26.00	15.55	93.00	55.63	336.00	200.97

DATE	FLOW (cfs)	TOTAL CD. (ppb)	TOTAL CD. (kgs/day)	TOTAL CU. (ppb)	TOTAL CU. (kgs/day)	TOTAL PB. (ppb)	TOTAL PB. (kgs/day)	TOTAL ZN. (ppb)	TOTAL ZN. (kgs/day)
07-May-90	200.22	0.90	0.44	5.00	2.45	29.00	14.21	91.00	44.58
08-May-90	149.97	1.60	0.59	5.00	1.83	36.00	13.21	109.00	39.99
09-May-90	128.99	1.00	0.32	7.00	2.21	27.00	8.52	83.00	26.19
15-May-90	114.41	1.10	0.31	6.00	1.68	29.00	8.12	77.00	21.55
22-May-90	123.31	0.90	0.27	13.00	3.92	79.00	23.83	82.00	24.74
14-Aug-90	40.47	2.40	0.24	1.50	0.15	12.00	1.19	129.00	12.77
17-Aug-90	39.89	0.70	0.07	1.50	0.15	9.00	0.88	134.00	13.08
18-Aug-90	36.61	0.70	0.06	1.50	0.13	9.00	0.81	127.00	11.37
22-Aug-90	42.24	0.60	0.06	1.50	0.16	12.00	1.24	125.00	12.92
25-Aug-90	41.05	0.60	0.06	1.50	0.15	12.00	1.21	144.00	14.46
26-Aug-90	40.47	0.60	0.06	1.50	0.15	21.00	2.08	137.00	13.56
27-Aug-90	39.89	0.25	0.02	1.50	0.15	1.50	0.15	87.00	8.49

	TOTAL CD. (ppb)	TOTAL CD. (kgs/day)	TOTAL CU. (ppb)	TOTAL CU. (kgs/day)	TOTAL PB. (ppb)	TOTAL PB. (kgs/day)	TOTAL ZN. (ppb)	TOTAL ZN. (kgs/day)
Mean Annual Conc.	2.97	0.78	9.83	2.41	42.23	12.04	157.79	39.29
n:	42	42	42	42	42	42	42	42
STD:	4.30	2.00	9.00	3.14	52.13	17.81	90.34	49.13
t0.5/2:	2.021	2.021	2.021	2.021	2.021	2.021	2.021	2.021
CI (+-mean Conc.):	1.36	0.63	2.84	0.99	16.45	5.62	28.51	15.51
Mean High Flow Conc.	1.73	0.59	8.44	3.27	46.19	17.45	155.06	54.95
n:	16	16	16	16	16	16	16	16
STD:	1.05	0.68	6.68	3.85	32.54	17.87	94.62	58.85
t0.5/2:	2.120	2.120	2.120	2.120	2.120	2.120	2.120	2.120
CI (+-mean Conc.):	0.57	0.37	3.66	2.11	17.81	9.78	51.80	32.21
Mean Low Flow Conc.	3.73	0.90	10.69	1.88	39.79	8.72	159.46	29.65
n:	26	26	26	26	26	26	26	26
STD:	5.26	2.47	10.08	2.46	61.02	16.95	87.55	39.04
t0.5/2:	2.056	2.056	2.056	2.056	2.056	2.056	2.056	2.056
CI (+-mean Conc.):	2.16	1.02	4.14	1.01	25.09	6.97	36.00	16.06

APPENDIX 5 - Summary of Metals Concentrations and Loads for River Stations, Point Source Stations and Derived Nonpoint Source Concentrations and Loads.

Summary of Concentrations and Loadings from River Stations, Point Source Stations, and Nonpoint Sources.

Time Regime	STATION #1 (nonpoint sources above study area)				STATION #2			
	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)
Annual Mean	0.265	0.265	0.030	0.030	0.585	0.350	0.001	0.001
High Flow Mean	0.250	0.250	0.049	0.049	0.579	0.336	0.001	0.001
Low Flow Mean	0.275	0.275	0.017	0.017	0.590	0.360	0.001	0.000
	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)
Annual Mean	7.235	3.985	0.929	0.349	10.824	4.118	0.016	0.006
High Flow Mean	7.857	1.714	1.652	0.330	12.143	4.000	0.022	0.008
Low Flow Mean	6.800	5.575	0.423	0.363	9.900	4.200	0.012	0.005
	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)
Annual Mean	3.571	1.891	0.565	0.208	68.912	10.441	0.115	0.013
High Flow Mean	5.121	1.664	1.158	0.335	99.643	10.071	0.186	0.018
Low Flow Mean	2.485	2.050	0.149	0.120	47.400	10.700	0.064	0.010
	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)
Annual Mean	26.412	5.559	2.461	0.784	69.706	31.882	0.114	0.055
High Flow Mean	50.714	6.286	5.187	1.478	97.000	44.000	0.174	0.083
Low Flow Mean	9.400	5.050	0.553	0.298	50.600	23.400	0.071	0.035
	SUS. SED. (mg/l)	SUS. SED. (kgs/day)			SUS. SED. (mg/l)	SUS. SED. (kgs/day)		
Annual Mean	1.647	220.716			3.882	6.309		
High Flow Mean	1.857	403.142			5.571	10.615		
Low Flow Mean	1.500	93.018			2.700	3.294		

Time Regime	STATION #4 TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)	STATION #5 TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)
Annual Mean	0.794	0.582	0.000	0.000	0.309	0.265	0.049	0.045
High Flow Mean	1.171	0.900	0.000	0.000	0.250	0.250	0.078	0.078
Low Flow Mean	0.530	0.360	0.000	0.000	0.350	0.275	0.028	0.021
	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)
Annual Mean	3.647	2.294	0.001	0.001	7.088	2.118	1.292	0.273
High Flow Mean	4.286	2.857	0.001	0.001	7.571	1.286	2.441	0.371
Low Flow Mean	3.200	1.900	0.001	0.000	6.750	2.700	0.489	0.204
	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)
Annual Mean	30.765	19.647	0.006	0.004	8.653	1.897	2.005	0.288
High Flow Mean	43.857	30.714	0.008	0.005	14.057	1.821	4.318	0.495
Low Flow Mean	21.600	11.900	0.005	0.003	4.870	1.950	0.386	0.143
	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)
Annual Mean	81.588	79.882	0.018	0.017	22.941	13.882	4.083	1.985
High Flow Mean	107.571	106.571	0.021	0.021	26.714	11.714	7.782	3.162
Low Flow Mean	63.400	61.200	0.015	0.015	20.300	15.400	1.494	1.162
	SUS.SED. (mg/l)	SUS.SED. (kgs/day)			SUS.SED. (mg/l)	SUS.SED. (kgs/day)		
Annual Mean	0.588	0.119			1.824	500.271		
High Flow Mean	0.857	0.152			3.000	1105.764		
Low Flow Mean	0.400	0.096			1.000	76.426		

Time Regime	Nonpoint Concentrations and Loadings Within Reach #2				STATION #6			
	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)
Annual Mean	0.411	0.236	0.017	0.014	0.903	0.665	0.002	0.001
High Flow Mean	0.214	0.240	0.027	0.028	1.050	0.764	0.002	0.002
Low Flow Mean	0.548	0.233	0.010	0.004	0.800	0.595	0.002	0.001
	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)
Annual Mean	1.459	-58.832	0.346	-0.083	8.706	2.912	0.021	0.007
High Flow Mean	5.917	-0.628	0.765	0.033	10.143	2.857	0.026	0.007
Low Flow Mean	-1.661	-99.575	0.052	-0.164	7.700	2.950	0.018	0.007
	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)
Annual Mean	27.286	1.160	1.320	0.062	175.647	79.500	0.415	0.188
High Flow Mean	46.025	3.255	2.966	0.137	175.286	77.500	0.443	0.189
Low Flow Mean	14.168	-0.306	0.167	0.009	175.900	80.900	0.395	0.187
	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)
Annual Mean	-55.397	69.453	1.491	1.129	159.588	128.706	0.384	0.300
High Flow Mean	-278.439	45.650	2.400	1.580	189.714	138.571	0.454	0.305
Low Flow Mean	100.733	86.116	0.854	0.814	138.500	121.800	0.335	0.297
	SUS.SED. (mg/l)	SUS.SED. (kgs/day)			SUS.SED. (mg/l)	SUS.SED. (kgs/day)		
Annual Mean	0.907	273.127			2.588	6.424		
High Flow Mean	5.746	691.855			3.429	9.300		
Low Flow Mean	-2.481	-19.982			2.000	4.411		

	STATION #7				STATION #8			
Time Regime	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)
Annual Mean	0.647	0.524	0.002	0.001	0.612	0.491	0.137	0.105
High Flow Mean	0.950	0.764	0.003	0.002	0.636	0.443	0.242	0.175
Low Flow Mean	0.435	0.355	0.001	0.001	0.595	0.525	0.064	0.056
	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)
Annual Mean	9.000	3.647	0.020	0.007	6.824	2.765	1.478	0.514
High Flow Mean	8.857	3.286	0.025	0.009	6.714	2.929	2.521	0.828
Low Flow Mean	9.100	3.900	0.016	0.006	6.900	2.650	0.748	0.294
	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)
Annual Mean	15.188	3.291	0.041	0.006	11.224	4.924	2.456	0.879
High Flow Mean	23.600	3.264	0.077	0.008	13.957	4.250	4.603	1.338
Low Flow Mean	9.300	3.310	0.015	0.005	9.310	5.395	0.953	0.558
	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)
Annual Mean	152.882	131.765	0.384	0.334	110.118	93.941	20.513	14.691
High Flow Mean	217.714	188.714	0.630	0.547	103.286	76.429	32.173	19.336
Low Flow Mean	107.500	91.900	0.212	0.184	114.900	106.200	12.352	11.440
	SUS.SED. (mg/l)	SUS.SED. (kgs/day)			SUS.SED. (mg/l)	SUS.SED. (kgs/day)		
Annual Mean	7.176	16.826			3.059	851.408		
High Flow Mean	9.286	26.199			5.143	1826.377		
Low Flow Mean	5.700	10.266			1.600	168.930		

Time Regime	Nonpoint Concentrations and Loadings Within Reach #3				Nonpoint Source Concs and Loadings Above River Station #8			
	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)	TOTAL CD. (ppb)	DISSL. CD. (ppb)	TOTAL CD. (kgs/day)	DISSL. CD. (kgs/day)
Annual Mean	1.668	0.807	0.085	0.057	0.603	0.488	0.133	0.101
High Flow Mean	2.004	-0.018	0.158	0.093	0.619	0.432	0.235	0.170
Low Flow Mean	1.432	1.385	0.034	0.032	0.591	0.527	0.061	0.053
	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)	TOTAL CU. (ppb)	DISSL. CU. (ppb)	TOTAL CU. (kgs/day)	DISSL. CU. (kgs/day)
Annual Mean	-9.489	8.321	0.145	0.227	6.721	2.753	1.420	0.494
High Flow Mean	-33.051	17.492	0.030	0.441	6.592	2.960	2.447	0.804
Low Flow Mean	7.004	1.901	0.226	0.078	6.812	2.608	0.701	0.276
	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)	TOTAL PB. (ppb)	DISSL. PB. (ppb)	TOTAL PB. (kgs/day)	DISSL. PB. (kgs/day)
Annual Mean	4.007	15.131	-0.005	0.398	7.389	3.552	1.879	0.668
High Flow Mean	1.670	25.109	-0.235	0.646	11.011	3.502	3.888	1.118
	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)	TOTAL ZN. (ppb)	DISSL. ZN. (ppb)	TOTAL ZN. (kgs/day)	DISSL. ZN. (kgs/day)
Annual Mean	443.148	424.620	15.662	12.072	108.960	93.468	19.614	13.985
High Flow Mean	484.478	479.493	23.307	15.322	100.672	74.649	30.894	18.380
Low Flow Mean	414.216	386.209	10.310	9.797	114.761	106.642	11.717	10.909
	SUS.SED. (mg/l)	SUS.SED. (kgs/day)			SUS.SED. (mg/l)	SUS.SED. (kgs/day)		
Annual Mean	10.060	327.887			3.234	821.730		
High Flow Mean	19.510	685.115			5.522	1780.111		
Low Flow Mean	3.445	77.827			1.633	150.863		

APPENDIX 6 - Tabulation of Field Parameter and Common ion Data.

Summary of Field Measurements at Sampling Stations.

River Station #1

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	14.6	1.4	66	28	30	6.7
01/19/90	14.9	1.1	81	36	33	7.53
01/24/90	15.03	1.8	78	40	36	7.31
02/15/90	NA	NA	NA	40	NA	NA
03/05/90	13.36	3.3	93	40	39	7.62
03/20/90	NA	4	NA	44	40	7.45
04/16/90	NA	5.6	49	24	22	7.45
04/25/90	11.75	5	45	20	16	7.23
05/09/90	10.5	5.5	44	20	18	7.05
05/30/90	9.4	7.3	30	16	13	6.98
06/04/90	NA	5.9	42	20	17	7.35
06/14/90	13.3	7.2	43	20	18	7.12
06/27/90	NA	11.4	39	36	21	7.33
07/16/90	10.3	13	75	32	29	7.25
07/19/90	11.26	11.9	71	32	32	7.41
07/23/90	10.69	12.5	77	36	33	7.48
08/01/90	10.7	12.7	84	40	35	7.23
08/09/90	10.7	13.5	89	40	38	7.21
08/14/90	10.64	15.4	89	44	40	7.38
08/30/90	10.8	11.1	96	44	42	7.41

Point Source Station #2

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	NA	NA	177	64	48	6.7
01/19/90	NA	NA	168	56	45	7.48
01/24/90	NA	NA	186	64	48	7.22
02/15/90	NA	NA	NA	NA	NA	NA
03/05/90	NA	NA	237	72	48	7.52
03/20/90	NA	NA	NA	72	45	7.47
04/16/90	NA	NA	283	92	37	7.62
04/25/90	NA	NA	305	104	40	7.51
05/09/90	NA	NA	258	88	41	7.63
05/30/90	NA	NA	232	80	41	7.2
06/04/90	NA	NA	247	80	41	7.56
06/14/90	NA	NA	270	92	39	7.64
06/27/90	NA	NA	179	64	48	7.72
07/16/90	NA	NA	267	88	48	8.5
07/19/90	NA	NA	261	92	48	8.29
07/23/90	NA	NA	286	96	47	8.24
08/01/90	NA	NA	289	96	50	7.34
08/09/90	NA	NA	297	96	44	8.09
08/14/90	NA	NA	283	96	48	7.8
08/30/90	NA	NA	293	104	48	7.2

River Station #3

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	14.01	1.4	72	36	33	6.5
01/19/90	13.8	1.5	84	40	37	7.43
01/24/90	13.75	2.2	85	44	39	7.51
02/15/90	NA	NA	NA	44	NA	6.7
03/05/90	11.8	3.9	112	48	44	7.66
03/20/90	NA	9.5	NA	52	44	7.59
04/16/90	NA	6.6	64	28	26	7.53
04/25/90	11.92	4.9	61	24	25	7.19
05/09/90	10.5	5.6	61	28	24	7.38
05/30/90	10	6.6	41	24	16	7.17
06/04/90	12.4	6.1	57	24	24	7.55
06/14/90	11.9	7.8	56	28	25	7.35
06/27/90	NA	10.9	47	24	25	7.65
07/16/90	11.3	13	81	32	33	7.55
07/19/90	11.18	12.1	78	36	35	7.56
07/23/90	11.25	12.2	84	36	35	7.61
08/01/90	10.5	12.2	91	104	40	7.61
08/09/90	11.04	13.2	101	44	32	7.75
08/14/90	11.26	15.1	97	44	43	7.74
08/30/90	10.98	10.6	108	48	43	7.91

Point Source Station #4

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	NA	NA	85	40	36	7
01/19/90	NA	NA	83	40	35	7.46
01/24/90	NA	NA	85	40	39	7.6
02/15/90	NA	NA	NA	NA	NA	NA
03/05/90	NA	NA	111	48	42	7.74
03/20/90	NA	NA	NA	40	33	7.87
04/16/90	NA	NA	DRY	DRY	DRY	DRY
04/25/90	NA	NA	DRY	DRY	DRY	DRY
05/09/90	NA	NA	264	60	78	7.84
05/30/90	NA	NA	DRY	DRY	DRY	DRY
06/04/90	NA	NA	DRY	DRY	DRY	DRY
06/14/90	NA	NA	DRY	DRY	DRY	DRY
06/27/90	NA	NA	DRY	DRY	DRY	DRY
07/16/90	NA	NA	DRY	DRY	DRY	DRY
07/19/90	NA	NA	DRY	DRY	DRY	DRY
07/23/90	NA	NA	DRY	DRY	DRY	DRY
08/01/90	NA	NA	DRY	DRY	DRY	DRY
08/09/90	NA	NA	DRY	DRY	DRY	DRY
08/14/90	NA	NA	DRY	DRY	DRY	DRY
08/30/90	NA	NA	DRY	DRY	DRY	DRY

River Station #5

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	13.98	1.4	77	40	34	6.9
01/19/90	13.48	1.7	88	40	37	7.59
01/24/90	13.75	1.8	88	44	40	7.38
02/15/90	NA	NA	NA	48	NA	NA
03/05/90	11.8	4.7	113	52	44	7.71
03/20/90	NA	5.7	NA	48	44	7.54
04/16/90	NA	7.1	62	28	25	7.48
04/25/90	10.7	5.2	58	28	24	7.32
05/09/90	12.32	6.9	57	32	18	7.41
05/30/90	11.7	7	39	20	19	7.19
06/04/90	12.3	6.6	54	24	23	7.13
06/14/90	11.74	8.1	53	28	24	7.3
06/27/90	10.28	10.8	45	28	24	7.3
07/16/90	10.07	13.8	83	40	33	7.41
07/19/90	9.49	13.6	81	40	35	7.39
07/23/90	10.26	14.1	88	40	37	7.34
08/01/90	10.17	13.4	92	56	38	7.44
08/09/90	10.1	14.3	104	44	41	7.25
08/14/90	11.88	16.4	101	44	44	7.66
08/30/90	10.88	11.4	109	48	42	7.6

Point Source Station #6

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	NA	NA	237	60	67	6.5
01/19/90	NA	NA	234	68	72	7.46
01/24/90	NA	NA	237	72	74	7.44
02/15/90	NA	NA	NA	NA	NA	NA
03/05/90	NA	NA	255	68	72	7.93
03/20/90	NA	NA	NA	72	78	7.81
04/16/90	NA	NA	242	56	75	8.12
04/25/90	NA	NA	200	44	55	5.5
05/09/90	NA	NA	172	48	53	7.86
05/30/90	NA	NA	181	48	59	7.79
06/04/90	NA	NA	205	52	60	7.84
06/14/90	NA	NA	213	52	62	7.78
06/27/90	NA	NA	198	60	64	7.74
07/16/90	NA	NA	245	56	59	7.53
07/19/90	NA	NA	261	68	67	7.65
07/23/90	NA	NA	207	56	66	7.65
08/01/90	NA	NA	253	48	62	7.62
08/09/90	NA	NA	304	64	74	7.65
08/14/90	NA	NA	253	60	68	7.72
08/30/90	NA	NA	236	56	70	7.78

Point Source Station #7

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	NA	NA	205	60	65	6.9
01/19/90	NA	NA	184	60	50	7.09
01/24/90	NA	NA	177	64	52	NA
02/15/90	NA	NA	NA	NA	NA	7.07
03/05/90	NA	NA	223	68	55	NA
03/20/90	NA	NA	NA	64	44	6.91
04/16/90	NA	NA	205	56	51	7.02
04/25/90	NA	NA	207	60	55	6.96
05/09/90	NA	NA	208	56	54	7.14
05/30/90	NA	NA	190	68	58	7.18
06/04/90	NA	NA	208	60	54	7.01
06/14/90	NA	NA	202	60	58	6.94
06/27/90	NA	NA	179	56	61	NA
07/16/90	NA	NA	204	48	58	NA
07/19/90	NA	NA	182	48	56	NA
07/23/90	NA	NA	197	48	57	NA
08/01/90	NA	NA	171	44	52	NA
08/09/90	NA	NA	180	48	56	NA
08/14/90	NA	NA	201	48	63	NA
08/30/90	NA	NA	167	44	50	NA

River Station #8

SAMPLE DATE	DISS. O2 (mg/l)	TEMP. (C)	COND. (umhos/cm)	HARD. (mg/l)	ALK. (mg/l)	PH UNITS
12/20/89	13.77	1.7	91	44	37	7
01/19/90	13.35	2.1	100	48	41	7.2
01/24/90	13.4	2.1	102	48	42	7.34
02/15/90	NA	NA	NA	48	NA	NA
03/05/90	11.78	5.1	132	56	46	7.55
03/20/90	NA	5.1	NA	56	45	7.58
04/16/90	NA	7.5	68	32	26	7.43
04/25/90	10.8	4.9	63	28	25	7.31
05/09/90	11.6	7.2	66	28	26	7.28
05/30/90	11.2	7.8	45	20	19	7.16
06/04/90	12.3	7	62	28	24	7.04
06/14/90	11.58	8.6	63	32	26	7.23
06/27/90	10.24	11.4	54	28	27	7.23
07/16/90	9.13	15.1	97	40	34	7.27
07/19/90	10.72	14.5	98	44	36	7.67
07/23/90	10.38	15.2	102	40	37	7.54
08/01/90	9.96	15.5	110	48	41	7.5
08/09/90	10.6	15.3	122	48	43	7.16
08/14/90	11.98	17.3	122	52	46	7.92
08/30/90	11.15	12.4	125	52	45	NA

APPENDIX 7 - Fisheries Data.

DRAINAGE	SFK CDA RIVER									
STATION	#1									
SAMPLING DURATION	49 MIN									
SAMPLING DISTANCE	100									
SAMPLING ARE (m^2)	570									
GEAR USED	ELECTRO									
PASS #	1									
		Length in (mm)								
GENUS/SPECIES	0-50	50-100	100-150	150-200	200-250	250+	# ANOM	TOTAL	#/per unit effort	% of refer
RAINBOW					4	2		6	0.122	100
CUTTHROAT		3	13	5	2	1		24	0.490	100
KOKANEE			1	2	3			6	0.122	100
BROOK		1						1	0.020	100
SHORTHEAD SCULPIN	7	27	5					39	0.796	100
FRY	5							5	0.102	100
								81		

DRAINAGE	SFK CDA RIVER									
STATION	#3									
SAMPLING DURATION	55 MIN									
SAMPLING DISTANCE	100									
SAMPLING AREA (m^2)	540									
GEAR USED	ELECTRO									
PASS #	1									
		Length in (mm)								
GENUS/SPECIES	0-50	50-100	100-150	150-200	200-250	250+	# ANOM	TOTAL	#/per unit effort	% of refer
RAINBOW						1		1	0.018	14.848
CUTTHROAT			11	2				13	0.236	48.258
KOKANEE				2				2	0.036	29.697
BROOK		1						1	0.018	89.091
SHORTHEAD SCULPIN	11	61						72	1.309	164.476
FRY	1	3						4	0.073	71.273
								93		

DRAINAGE	SFK CDA RIVER
STATION	#5
SAMPLING DURATION	63 MIN
SAMPLING DISTANCE	100
SAMPLING AREA (m^2)	715
GEAR USED	ELECTRO
PASS #	1

GENUS/SPECIES	0-50	Length in (mm) 50-100	100-150	150-200	200-250	250+	# ANOM	TOTAL	#/per unit effort	% of refer
RAINBOW					4			4	0.063	51.852
CUTTHROAT		3	5	2	3	2		15	0.238	48.611
KOKANEE								0	0.000	0.000
BROOK								0	0.000	0.000
SHORTHEAD SCULPIN	6	75	6				1	88	1.397	175.499
FRY	4	8						12	0.190	186.667
								119		

DRAINAGE	SFK CDA RIVER
STATION	#8
SAMPLING DURATION	68 MIN
SAMPLING DISTANCE	100
SAMPLING AREA (m^2)	620
GEAR USED	ELECTRO
PASS #	1

GENUS/SPECIES	0-50	Length in (mm) 50-100	100-150	150-200	200-250	250+	# ANOM	TOTAL	#/per unit effort	% of refer
RAINBOW					1	1		2	0.029	24.020
CUTTHROAT		2	24	5			1	32	0.471	96.078
KOKANEE				5	3			8	0.118	96.078
BROOK		8	2					10	0.147	720.588
SHORTHEAD SCULPIN	7	13	5					25	0.368	46.192
FRY	1	1						2	0.029	28.824
								79		

Costs associated with this publication are available from Department of Health and Welfare in accordance with Section 60-202, Idaho Code.

IDHW-75,48G29,12/93,cost per unit:$5.12

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