Research Technical Completion Report

WATER QUALITY ASSESSMENT OF CLARK FORK RIVER IN IDAHO

by

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TABLE OF CONTENTS

ABSTRACT	i
LIST OF TABLES	ii
INTRODUCTION	1
METHODS	1
Instream Sampling	2
Water Quality Parameters	2
Sample Analyses	2
Estimate of Daily Suspended Load	3
RESULTS AND DISCUSSION	3
Historic Analysis	3
Instream Sampling	3
Daily Suspended Load	9
CONCLUSIONS	9
ACKNOWLEDGEMENTS	12

ABSTRACT

The water quality of the Clark Fork River at Clark Fork, Idaho, was monitored from June 1984 to May 1985. The following water quality parameters were measured: dissolved oxygen, biochemical oxygen demand, suspended solids, volatile suspended solids, alkalinity, ortho-phosphorus, nitrate-nitrogen, color, and hydrogen ion activity (pH). These data were combined with Environmental Protection Agency Water Quality trend data (1968-1984) for the same sampling station to determine the general water quality status of the Clark Fork River prior to its confluence with Lake Pend Oreille. The data from this study and EPA indicate point and non-point source loading of pollutants is occurring.

LIST OF TABLES

TABLE PAGE

1. The Sampling Dates and Stations at the Clark Fork Bridge. 4

2. Concentrations of the Water Quality Parameters Measured at the Clark Fork Station During the Study Period. 6

3. The Average Daily Suspended Load for the Sampling Periods 10

4. The Average Instantaneous Flow Rate for the Sampling Periods and the Average Monthly Instantaneous Flow Rate. 11

APPENDIX 1. Water Quality Data From the Environmental Protection Agency Monitoring Program for the Clark Fork River at Clark Fork During 1968-1984. 13

INTRODUCTION

The streams, rivers and lakes of Idaho represent a significant resource which provides opportunities for various uses. Many of these waters are of high quality. However, concern for potential deterioration of relatively pristine water has produced an awareness of the need for assessment of the present quality of these waters with identification of the natural phenomena and human activities which may create adverse changes.

In many areas of the state, the local economy is partially dependent on tourism which requires a clean lake-river system. Deterioration of water quality in these areas can be directly linked to deterioration of the quality of life.

Lake Pend Oreille and its tributaries have recently received attention with regards to the need for assessment of water quality and for management of the watershed and shoreline to control point and nonpoint sources of pollutants into the lake. The residents of Sandpoint and Lake Pend Oreille, as well as recreational users of the area, are concerned about the present and future water quality of the lake and its tributaries. An investigation of the present water quality of Lake Pend Oreille and its major tributaries is needed to permit proper planning for future development of the watershed and shoreline and to control the influx of pollutants via direct and diffuse sources.

This study was designed to investigate the water quality of the Clark Fork River which is the major inflow source of Lake Pend Oreille. The objectives of the study were to:

1. assess the water quality of the Clark Fork River in Idaho.
2. determine the flux of suspended solids, nitrogen and phosphorus from the Clark Fork River into Lake Pend Oreille.

METHODS

The methods employed for meeting the above objectives were two-fold. A review of past studies related to water quality of the Clark Fork River in Idaho was conducted to obtain a historic perspective of the influx of pollutants into Lake Pend Oreille from the Clark Fork watershed. Instream sampling of the Clark Fork River at Clark Fork, Idaho, was conducted from June 1984 - May 1985. Several water quality parameters were measured during the sampling period.

Instream Sampling

The water column of the Clark Fork River was sampled from the Clark Fork bridge at Clark Fork. Due to limited funding, sampling was conducted once per month from June 1984 through May 1985.

Nine stations were marked along the bridge to assure sample collection at defined distances in the channel cross-section. The initial design included sampling at each of the nine stations with a possible decrease in stations if variability in data between stations was not significant. The sampling depth for each period of measurement was determined by the depth of flow at the end sampling stations. Information regarding sampling dates, depths, etc. are presented in Table 1, in the results section.

Water column samples were collected with a Kemmerer bottle.

Water Quality Parameters

The water quality parameters selected for this study were limited to those which would reflect the general status of water quality with respect to nutrient and suspended solid loading. Several parameters were initially identified as important indicators of water quality for the major beneficial uses of Lake Pend Oreille. However, funding constraints limited analysis to the following parameters.

Dissolved Oxygen (DO)
Biochemical Oxygen Demand (BOD)
Suspended Solids (SS)
Volatile Suspended Solids (VSS)
Color
Hydrogen Ion Activity (pH)
Alkalinity
Ortho-phosphorus (PO_4)
Nitrate-nitrogen (NO_3-N)

Sample Analyses

Two samples were collected at each station during a sampling period. One sample was kept cool without additives. The second sample was fixed with sulfuric acid to pH<2 and kept cool for nitrate-nitrogen and color analysis.

Analyses of water column samples were conducted in the field and laboratory. The Sandpoint Sewage Treatment Plant personnel conducted the analysis for BOD, pH, PO_4, alkalinity, SS, and VSS. Analyses for color and NO_3-N were conducted at the laboratory in the College of Forestry, Wildlife and Range

Sciences, University of Idaho. Dissolved oxygen was measured on site. All analyses were conducted according to standard procedures (APHA 1980).

Estimate of Daily Suspended Load

Daily discharge data for the Clark Fork River were obtained from the USGS office in Boise, Idaho. The flow data were from the station at White Horse rapids near Cabinet, Idaho, which is a few miles above the water quality sampling station.

An estimate was made of the total suspended load for the day of sampling. The average daily discharge (cfs) was combined with the concentration (mg/l) of a parameter to calculate the total suspended load (tons/day) for that parameter during that day. The estimate was calculated for NO_3-N, PO_4, BOD_5, SS,and VSS.

RESULTS AND DISCUSSION

Historic Analysis

The search for past water quality monitoring of the Clark Fork River in Idaho revealed that the Environmental Protection Agency (EPA) had conducted some sampling for water quality trend data at Clark Fork, Idaho. These data were acquired via the STORET computer retrieval system. A summary of these data are presented in Appendix I. The levels of water quality parameters are not alarmingly high. They appear to represent water which has had an influx of pollutants as evidenced by the presence of heavy metals, fecal and streptococci coliform bacteria and other contaminants. Given the myriad of point and non-point sources from the watershed above the Clark Fork station these levels are low relative to the potential which exists for contamination.

Instream Sampling

The original study plan included sampling of the water column at the Clark Fork bridge at a schedule of once per month from June 1984 through May 1985. However, sampling did not occur during November and December, 1984 due to inclement weather.

The sampling dates and associated information are presented in Table 1. No significant differences in variance existed in measurements for five or nine stations within the cross-section of the water column. Therefore, sample size was reduced to five stations from January - May 1985.

Table 1. The sampling dates and stations at the Clark Fork Bridge.

DATE	DEPTH[1] (FT)	STATION	DISTANCE[2] (FT)
06-24-84	1.5[3]	1-9	19.5
07-28-84	2.5	1-9	23.4
08-25-84	2.5	1-9	23.4
09-29-84	2.5	1-9	24.7
10-25-84	1.5	1,3,5,7,9	26.5
01-26-85	1.5	1,3,5,7,9	26.9
02-23-85	1.5	2,3,5,7,9	27.9
03-30-85	1.5	1,3,5,7,9	25.8
04-27-85	1.5	2,3,5,7,9	29.5
05-17-85	2.5	1,3,5,7,9	23.1

1 - Depth represents location of sample collection with reference to water surface.
2 - Distance represents the depth to water surface from a reference point on the bridge.
3 - The 1.5 depth includes an integrated sample which represents the water column from 0 - 1.5 feet.
All samples were collected from 0900 - 1100 hours.

The water quality data for the study period are presented in Table 2. These data represent the water column at a specific depth and point in time (Table 1).

The average dissolved oxygen concentrations ranged from 9.6 mg/l in May, 1985 to 15.1 mg/l in January, 1985 (Table 2). These values are well above critical minimum levels for fish. The re-aeration produced at the Cabinet Gorge power facility is part of the reason for high DO levels in the river at Clark Fork. These data are similar to the EPA data (Appendix I).

The BOD_5 levels were low throughout the study period. The maximum level of 2.0 mg/l occurred in January, 1985 (Table 2). These data indicate that low levels of organics were present at the depths sampled. The EPA trend data had one measurement for BOD_5 of 1.14 mg/l.

The average pH ranged from 7.1 to 8.2 (Table 2) which was similar to the EPA values.

Calcium carbonate alkalinity ranged from 64 mg/l in April, 1985 to 93 mg/l in October, 1984 and January, 1985 (Table 2). These levels were also similar to the EPA data.

The ortho-phosphorus levels varied from average values of <0.01 to 3.5 mg/l (Table 2). With exception of April, 1985 all of the concentrations were greater than or equal to 0.40 mg/l. The PO_4 concentrations measured during this study period were significantly higher than the levels reported during the EPA monitoring program. Perhaps the influx of phosphorus compounds has increased since 1983. Further monitoring is necessary before a definitive, sustained increase in phosphorus can be verified.

The average nitrate-nitrogen concentrations ranged from 0.02 to 0.23 mg/l during the study period (Table 2). The higher values of this compound coupled with the phosphorus levels are indicative of waters which would have high potential for aquatic plant growth. The NO_3 -N levels measured in this study were similar to the EPA data.

The filterable suspended solids concentrations were low during the study period (Table 2) compared to the EPA data (Appendix I). The average concentrations ranged from 2 - 13 mg/l during the study period compared to an average level of 121.8 mg/l during the EPA monitoring period. The reservoirs which have been constructed in the Clark Fork River provide a storage component for suspended and bed load materials. The suspended solids in the river at Clark Fork represents the materials which have passed through the reservoirs such as at Noxon and Cabinet Gorge, plus from the tributaries below Cabinet Gorge. An assessment of the suspended load above and

Table 2. Concentrations of the water quality parameters measured at the Clark Fork station during the study period.

DATE STA.	DO	BOD	pH	ALK	PO_4	NO_3-N	SS	VSS
				(mg/l)				
June 24, 1985								
1	12.7	1.7	8.0	61	-	0.02	16	3
2	12.5	1.8	8.1	63	0.4	-	12	5
3	12.3	1.5	8.0	61	0.4	0.03	11	4
4	12.1	1.6	8.0	62	-	-	14	4
5	12.1	2.0	8.0	60	-	0.03	12	4
6	12.0	1.4	8.1	72	0.3	-	12	3
7	12.0	1.6	8.0	61	-	-	14	4
8	11.8	1.3	8.0	60	0.4	0.04	14	3
9	11.7	2.0	7.8	61	0.5	<.01*	13	1
Mean	12.1	1.7	8.0	67	0.4	0.03	13	3
Std.D.	0.3	0.2	0.1	3.7	0.1	0.01	1.5	1.1
July 28, 1984								
1	11.8	0.7	6.4	80	0.4	0.02	4	1
2	13.0	1.6	8.0	76	0.4	-	8	5
3	13.0	2.6	8.1	71	0.4	0.03	11	12
4	12.8	0.8	8.0	76	0.3	0.07	15	7
5	13.0	1.2	7.9	78	0.3	-	6	4
6	12.8	1.3	8.2	77	0.3	0.12	8	3
7	13.0	0.8	8.2	76	0.5	-	7	5
8	13.2	0.5	8.2	76	0.5	-	13	6
9	12.8	0.3	8.0	74	0.4	0.04	14	9
Mean	12.8	1.1	7.9	76	0.4	0.06	9	6
Std.D.	0.4	0.7	0.06	2.5	0.1	0.04	3.8	3.3
August 25, 1984								
1	14.5	0.7	8.0	87	3.9*	0.15	4	3
2	13.2	0.9	8.1	86	0.6	-	5	2
3	12.5	1.0	8.2	87	0.4	0.27	6	4
4	12.7	0.4	8.2	89	0.5	-	5	3
5	12.5	0.6	8.2	85	0.3	0.08	7	3
6	12.5	0.5	8.2	84	0.5	-	8	4
7	12.7	1.5	8.2	86	0.6	0.06	13	6
8	12.7	0.5	8.2	85	0.2	-	9	5
9	12.9	0.3	8.3	84	0.4	0.12	8	3
Mean	12.9	0.7	8.2	86	0.4	0.14	7	4
Std.D.	0.6	0.4	0.1	1.6	0.1	0.08	2.7	1.2

* - Data not included in statistical analyses

Table 2, Continued:

DATE STA.	DO	BOD	pH	ALK	PO_4	NO_3-N	SS	VSS
September 29,1984								
1	13.0	1.3	8.2	90	0.3	-	14	8
2	13.0	0.9	8.2	88	0.2	0.02	6	4
3	13.0	0.9	8.2	90	0.3	-	5	5
4	12.8	0.8	8.1	84	0.2	0.02	10	9
5	12.8	0.5	8.2	92	0.2	-	8	8
6	13.0	0.6	8.3	92	0.3	0.02	8	4
7	13.0	0.6	8.2	90	0.2	-	10	10
8	13.0	0.4	8.0	92	30.0*	0.02	3	3
9	13.0	0.4	8.2	76	0.3	0.04	16	16
Mean	12.9	0.7	8.2	88	0.2	0.02	9	7
Std.D.	0.1	0.3	0.1	5.2	0.05	0.01	4.2	4.1
October 25,1984								
1	13.4	0.4	7.9	98	0.2	0.03	3	1
3	14.2	0.4	8.0	94	0.3	-	2	1
5	13.4	1.8	8.0	90	0.5	0.02	10	2
7	13.0	1.1	8.0	96	0.4	<.01*	2	1
9	13.0	0.9	8.0	88	0.4	-	1	0
Mean	13.4	0.9	8.0	93	0.4	0.02	4	1
Std.D.	0.5	0.8	0.0	4.1	0.1	0.01	3.6	0.7
January 26,1985								
1	16.0	2.3	7.5	93	25.0*	-	8	6
3	15.3	1.6	6.8	93	5.0	0.04	12	4
5	14.5	2.1	7.0	100	2.0	-	11	3
7	14.5	1.9	7.3	97	4.0	0.04	12	8
9	15.4	2.0	6.8	83	3.0	0.05	7	2
Mean	15.1	2.0	7.1	93	3.5	0.04	10	4.6
Std.D.	0.6	0.3	0.3	6.4	1.3	0.01	2.3	2.4

* - Data not included in statistical analyses

Table 2, Continued:

DATE STA.	DO	BOD	pH	ALK	PO_4	NO_3-N	SS	VSS
February 23,1985								
2	14.0	0.1	7.5	70	0.5	0.07	2	0
3	14.6	0.0	7.4	70	0.5	-	4	0
5	14.0	0.0	7.6	70	0.5	0.05	1	1
7	14.4	0.0	7.3	72	0.5	-	2	1
9	13.6	0.5	6.8	54	0.5	0.08	47*	11*
Mean	14.1	0.1	7.3	67	0.5	0.07	2	0.5
Std.D.	0.4	0.2	0.3	7.4	0.0	0.02	1.3	0.6
March 30,1985								
1	-	3.0	7.5	50	0.5	3.10*	5	3
3	14.2	4.0	7.6	76	0.5	-	3	0
5	-	4.0	7.7	70	0.4	0.14	5	3
7	13.2	2.0	7.7	74	0.4	0.31	3	-
9	13.2	0.0	7.7	76	0.4	-	2	-
Mean	13.5	2.6	7.6	69	0.4	0.23	3.6	2
Std.D.	0.6	1.7	0.1	11	0.0	0.12	1.3	1.7
April 27,1985								
2	9.1	0.2	7.4	44	<.1*	-	4	-
3	10.2	0.4	7.6	70	<.1	0.13	4	-
5	10.2	0.3	7.6	70	<.1	0.10	4	-
7	9.1	0.1	7.6	64	<.1	-	4	-
8	9.7	0.2	7.7	70	<.1	0.09	2	-
Mean	9.7	0.2	7.6	64	-	0.11	3.6	-
Std.D	0.5	0.1	0.1	11.3	-	0.02	0.9	-
May 17,1985								
1	10.2	0.6	7.7	70	0.3	0.21	9	3
3	9.1	0.5	7.8	68	0.5	-	8	3
5	10.2	0.8	7.8	70	0.5	0.04	8	3
7	9.1	0.5	7.8	70	0.4	0.04	6	2
9	9.1	0.6	7.7	68	0.5	-	6	2
Mean	9.6	0.6	7.8	69	0.4	0.10	7	2.6
Std.D.	0.6	0.1	0.05	1.1	0.1	0.10	1.3	0.5

* - Data not included in statistical analyses

below these structures is needed before the trapping efficiency can be determined. It is plausible to state that the suspended load at Clark Fork bridge is affected by these reservoirs. The suspended and bed load fractions would most likely be higher at this station if the reservoirs did not exist.

The volatile suspended solids which represent the organic fraction ranged from 0.5 to 7.0 mg/l (Table 2). These data coincide with the BOD levels which were measured.

Water color values were less than 10 for all of the samples indicating that contaminants such as organic acids were not present in large quantities. These color values support the suspended solids data. The color levels in the EPA data were 5.0 for all the collection periods.

Daily Suspended Load

The average daily suspended load during the sampling periods for NO_3-N ranged from .5 - 10 tons/day (Table 3). PO_4 loads varied from 5 - 109 tons/day. BOD loads ranged from 3-304 tons/day. SS and VSS loads were 65 - 2323 tons/day and 15 - 536 tons/day, respectively.

The amount of daily suspended load from the Clark Fork River which remains in storage in Lake Pend Oreille is unknown. Some of the load is transient as it moves through the lake to the Pend Oreille river. The average annual discharge from the Clark Fork River into Lake Pend Oreille is approximately 16,240,000 acre-feet. The storage capacity of the lake is approximately 2,462,00 acre-feet. Thus, much of the Clark Fork inflow moves through the lake. Some of the suspended fraction also moves through the lake system. A hydrologic inflow-storage-outflow budget which includes suspended and bedload materials needs to be developed before it can be determined how much of the Clark Fork River suspended load remains in the lake.

The average instantaneous flow rates for the sampling periods were compared with the average instantaneous flow rates for the respective months to determine if the flow during sample collection was indicative of normal flow rates. The flow rates during the sampling periods were below the average monthly rate for all cases with exception of June and August, 1984 (Table 4).

CONCLUSIONS

The water quality data from the EPA trend monitoring program and this study indicate that pollutants are entering

Table 3. The average daily suspended load for the sampling periods.

DATE	Q (CFS)	NO_3-N	PO_4	BOD (TONS/DAY)	SS	VSS	%VSS
6-24 84	66400	5	72	304	2323	536	23
7-28 84	10600	2	11	31	257	171	66
8-25 84	12300	5	13	23	232	132	57
9-29 84	8360	.5	5	16	202	157	78
10-25 84	12300	1	13	30	122	33	27
1-26 85	11600	1	109	62	312	144	46
2-23 85	11000	2	15	3	65	15	23
3-30 85	12100	7	13	85	117	65	56
4-27 85	8940	3	-	5	87	-	-
5-17 85	37700	10	41	61	751	264	35

Table 4. The average instantaneous flow rate for the sampling periods and the average monthly instantaneous flow rate.

MONTH/YEAR	AVERAGE Q SAMPLE PERIOD (cfs)	AVERAGE Q MONTH
06-84	66400	51400
07-84	10600	24250
08-84	12300	11490
09-84	8360	14010
10-84	12300	14760
01-85	11600	14810
02-85	11000	14160
03-85	12100	15850
04-85	8940	22490
05-85	37700	38670

the Clark Fork River. The presence of heavy metals, fecal and streptococci bacteria, and other contaminants indicate that point and non-point source loading is occurring. However, the levels of these contaminants were not exceptionally high. This is not to imply that the daily loading of these contaminants which in some cases represent tons of materials per day is not producing changes in the aquatic ecosystem of Lake Pend Oreille. The levels of these contaminants as presented are within the water quality standards of the State of Idaho.

The limited scope of this study did not permit indepth analysis of the water quality of the Lake Pend Oreille system. These data provide some insight into the quality of water of the Clark Fork river prior to its confluence with the lake.

The question regarding the affect of water borne pollutants on the lake ecosystem will remain unanswered until a comprehensive, long term study is conducted.

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APPENDIX 1:

Water quality data from the Environmental Protection Agency monitoring program for The Clark Fork River at Clark Fork during 1968-1984.

PARAMETER	N	MEAN	STD.DEV.	MAX	MIN	DATE
Streamflow (cfs)	129	24278	18419	95000	5670	68-83
Temp (C)	105	10.4	5.9	21.2	1.5	68-84
Color	5	5.0	0.0	5.0	5.0	68-73
DO(mg/l)	97	11.2	1.7	16.0	7.5	68-84
BOD_5(mg/l)	1	1.4	-	1.4	1.4	10-16-75
pH(field)	92	7.6	0.5	8.8	6.0	68-84
(lab)	92	7.5	0.3	8.3	6.8	68-84
T.Alk. $CaCO_3$(mg/l)	109	79.6	18.2	136.0	6.5	68-84
T.Residue (mg/l)	108	121.8	34.7	256.0	59.6	68-84
T.NO_3-N (mg/l)	35	0.13	0.26	1.37	0.02	68-78
T.PO_4 (mg/l)	3	0.16	0.15	0.32	0.02	74-75
T.Chloride (mg/l)	100	3.4	6.1	54.0	0.27	68-83
T.SO_4(mg/l)	33	10.5	5.2	29.0	1.0	68-83
T.Fluoride (mg/l)	52	0.14	0.05	0.40	0.01	68-83
T.Arsenic (ug/l)	57	10.0	0.0	10.0	10.0	78-83
T.Cadmium (ug/l)	67	3.1	3.0	14.0	1.0	69-83
T.Chromium (ug/l)	59	48.6	7.3	50.0	10.0	73-83
T.Copper (ug/l)	69	12.1	13.6	100.0	1.0	68-83
T.Mercury (ug/l)	6	1.4	1.0	3.4	0.6	78-82
T.Lead (ug/l)	69	44.2	14.1	50.0	10.0	68-83
Zinc(ug/l)	69	6.5	14.7	90.0	1.0	68-83
T.Coli/100ml mfimendo	101	109	455	3750	0.0	69-84
Fec.Coli/100ml mfm-fcbr	87	9	58	550	0.0	73-84
Fec.Strep /100ml mf m-ent	85	22	130	1200	0.0	75-84

These data are from STORET, 04-23-84.