



Idaho State Department of Agriculture
Division of Agricultural Resources



Lower Jacks Creek Water Quality Monitoring Report April 1999 through March 2001

Prepared for
Bruneau Cattle Company
Bruneau River SCD

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ISDA Technical Results Summary No. W-4

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Introduction

This technical report presents water quality data collected by the Idaho State Department of Agriculture (ISDA) on Lower Jacks Creek from April 1999 through March 2001. Jacks Creek is on the State of Idaho 303(d) list as having impaired water quality due to dissolved oxygen, flow alteration, nutrients, sediment and temperature. ISDA was requested by Mr. Eric Davis (owner/operator) of the Bruneau Cattle Company to assist in water quality evaluation of Lower Jacks Creek, which flows through his property.

Monitoring was made possible by state funding that allows ISDA to support the Soil Conservation Commission (SCC), Idaho Soil Conservation Districts (SCDs) and lo-

cal farmers and ranchers with the implementation phase of the Total Maximum Daily Load (TMDL) process. Monitoring will help assist in understanding the source and transport of contaminants from various agricultural practices. In addition, information gathered will help fill data gaps, calculate pollutant load allocations and insure that Best Management Practices (BMPs) are established in areas of need and are functioning properly for pollutant reduction.

Background

Jacks Creek is located within Hydrological Unit Code (HUC) 17050102 within Owyhee County. It begins at the confluence of Big Jacks Creek and Little Jacks Creek and

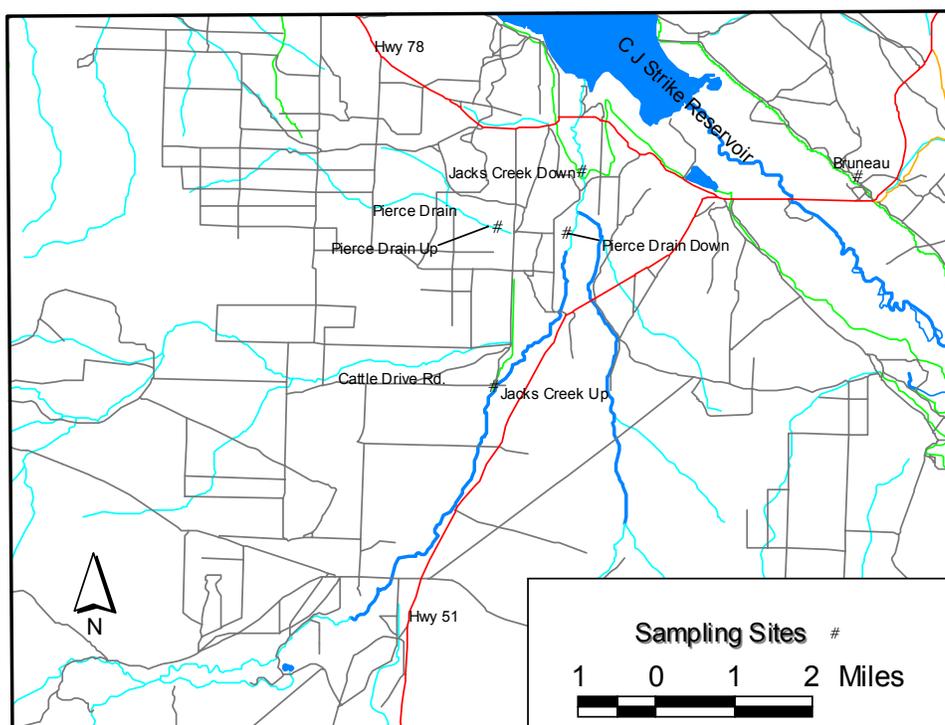


Figure 1. ISDA sampling sites on Jacks Creek (April 1999 to March 2001)

flows north into C.J. Strike Reservoir. Two sites were monitored on Jacks Creek, an upstream site (Jacks Creek Up) was selected where Jacks Creek enters Burneau Cattle Company property downstream of Cattle Drive Road (Figure 1). The downstream site (Jacks Creek Down) was located on company property approximately 1.3 miles upstream from C.J. Strike Reservoir (Figure 1). Both sites were monitored over a two-year period with samples collected twice a month during April through October and monthly during November through March. During the second year of monitoring, two additional sites were added to the program. These sites were named Pierce Drain Up and Pierce Drain Down (Figure 1). The two sites were added to determine input from the drain that flows onto company property from the east and eventually enters Jacks Creek. The drain flows primarily during the irrigation season. Flow consists almost entirely of shallow ground water recharge. Samples were not collected, at the completion of the irrigation season, due to lack of water in the drain (late fall and winter months).

Total Maximum Daily Load (TMDL)

The Bruneau Subbasin Assessment and Total Maximum Daily Load (TMDL), which includes Jacks Creek, was submitted by the Idaho Department of Environmental Quality (IDEQ) to the Environmental Protection Agency (EPA) and approved on March 20, 2001. The approved TMDL, requires reductions in nutrients (phosphorus), bacteria and efforts to stabilize diurnal dissolved oxygen fluctuations to within state standards.

Results

Total Suspended Solids

According to the approved TMDL, total suspended solids (TSS) are not to exceed a monthly average of 50 mg/L with a daily TSS maximum of 83 mg/L to allow for natural variability.

ISDA data at Jacks Creek Down indicated only one exceedance of the daily maximum limit of 83 mg/L during the two years. This exceedance (100 mg/L) occurred on April 22, 1999. At the Jacks Creek Upstream site, none of the measurements, over the two year period exceeded the daily maximum of 83 mg/L (Appendix A).

At the upstream site, seven samples (18%) exceeded the monthly average of 50 mg/L. The downstream site had 11 samples (29%) exceeding the TMDL monthly TSS average criteria (50 mg/L). Most of these higher TSS values occurred at the downstream site during the

early spring and late fall to winter months. Insufficient data points were available to calculate an accurate monthly TSS average.

Total Phosphorus (TP)

IDEQ has followed EPA suggested guidelines (USEPA, Quality Criteria for Water, 1987) to establish concentration limits for total phosphorus (TP) in Jacks Creek. The guidelines state that for streams entering a lake or reservoir TP should not exceed 0.05 mg/L. Following this guidance IDEQ established the 0.05 mg/L TP limit for Jacks Creek.

At the upstream station on Jacks Creek the two year mean concentration for TP was 0.34 mg/L. At the upstream site both year one and year two had identical mean concentrations of 0.34 mg/L. The dissolved phosphorus mean concentration for years one and two was 0.22 and 0.17 mg/L respectively. On average (over the two year period) the dissolved phosphorus at the upstream site comprised over half (57.5%) of the total phosphorus.

At the downstream station, the mean concentration for TP during the first year of monitoring was 0.26 mg/L. The second year mean concentration for TP was 0.21 mg/L. The overall average TP concentration over the two-year study was 0.24 mg/L. As with the upstream site the average dissolved phosphorus concentration made up approximately 57% of the total phosphorus.

Using the established TMDL concentration of 0.05 mg/L, a TP load reduction of 79% would be required at the upstream and downstream site for Jacks Creek to meet the TMDL requirements (Table 1).

High primary production can lower the concentration of

Table 1. Total Phosphorus load reductions

Reference	Average Total Phosphorus (mg/L)	Load lbs/day	% Reduction to meet TMDL
TMDL requirement	0.05 mg/L	2.5	NA
Jacks Creek Upstream	0.34 mg/L	12	79%
Jacks Creek Downstream	0.24 mg/L	11.8	79%

Load Calculation = average mg/L x mean discharge x 5.39 (constant) NA= non applicable

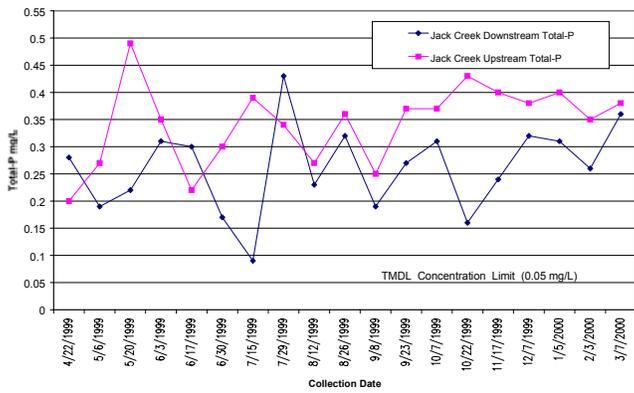


Figure 2. Total Phosphorus Concentrations (1999-2000)

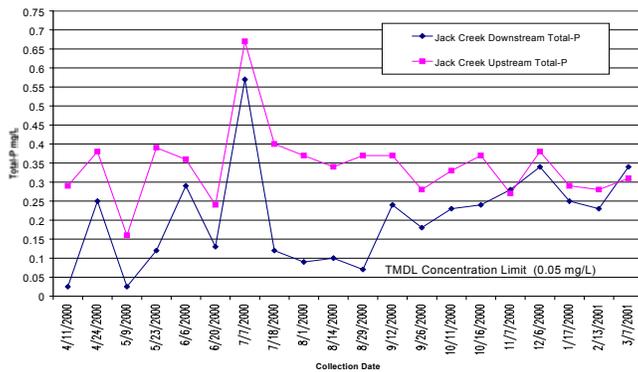


Figure 3. Total Phosphorus Concentrations (2000-2001)

phosphorus due to rapid uptake of phosphate by algae and other aquatic plants. Primary production is the synthesis of nutrients and organic matter by algae, and other aquatic plants, in the production of oxygen (photosynthesis).

During both years of this study the phosphorus concentration at the downstream site was considerably lower (during the critical growth period) when compared to upstream (Figure 2 and 3). This decrease could relate directly to the amount of excessive aquatic vegetation downstream that utilizes the phosphorus during the prime production period.

Sources of Phosphorus

Monitoring of Pierce drain, prior to the confluence with Jacks Creek, indicated the average TP concentration was 0.21 mg/L. The average discharge was quite low for Pierce Drain (0.72 cfs) so the average calculated TP load entering Jacks Creek was 0.81 lbs/day.

A possible source of increased TP could be the warm water fish farms that discharge into the creek. One set of samples was collected (with the permission of Mr. Eric

Davis) from the effluent discharge of one of the fish farms. How representative this one sample set is of the overall operation and effluent characteristics of the farm is not known.

The data indicated that 30 mg/L (77%) of the TSS value of 39 mg/L was total volatile suspended solids (TVSS) or organic solids. If this data point is representative, of the effluent, it would indicate that approximately 467 lbs/day of organic solids are entering Jacks Creek from this facility.

The effluent total phosphorus concentration was 0.48 mg/L and the dissolved phosphorus was 0.16 mg/L. The discharge rate was 2.89 cfs, and the calculated load of phosphorus discharging into Jacks Creek was 7.5 lbs/day.

If this data point is representative, it indicates that over one-half of the phosphorus load carried by Jacks Creek comes from the fish farm effluent. It could be possible that the effluent from the two point sources (fish farms) contribute the bulk of phosphorus into Lower Jacks Creek.

Other possible sources for TP could come from irrigation return waters, animal waste and natural or man caused erosion.

Dissolved Oxygen (DO)

The approved TMDL for Jacks Creek lists dissolved oxygen (DO) concentrations as a concern. For slow moving streams and rivers with high primary productivity, large diurnal fluctuations in DO concentrations can result from aquatic plants photosynthesis and respiration. During the day photosynthesis in excess of respiration is a source of oxygen. At night photosynthesis ceases and respiration becomes an oxygen sink. Nocturnal respiration can cause oxygen depletion in waters with high primary production and low reaeration rates.

Visual observations, indicated a high concentration of aquatic vegetative growth that almost completely covers the substrate of Jacks Creek during the peak growing season (summer and early fall). At times the water had a greenish hue and filtered portions of the samples turned the filter green.

The high concentration of DO and percent saturation (at times supersaturation) measured at the downstream site is a strong indicator of excessive aquatic plant biomass (Figure 4 and 5).

Diurnal fluctuation in the system could reach extremely low DO levels during night time plant respiration, aquatic

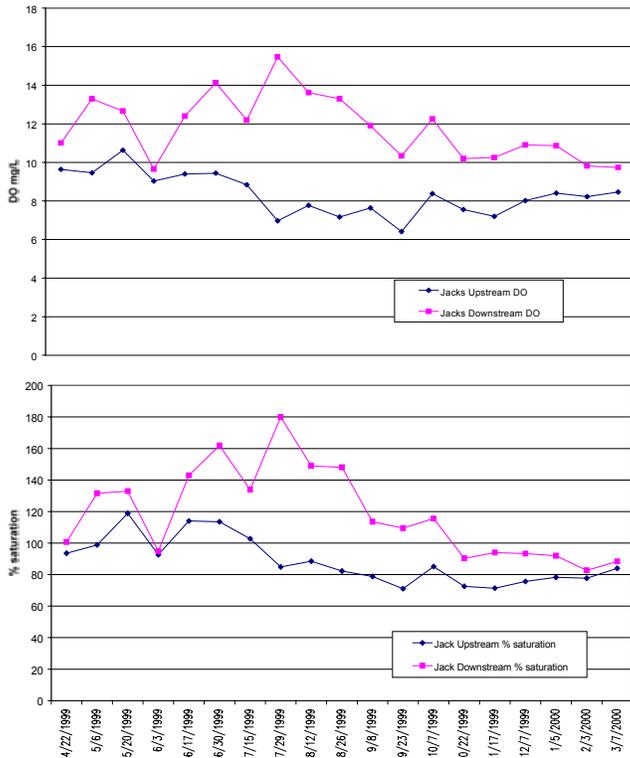


Figure 4. Year one DO and percent saturation concentrations

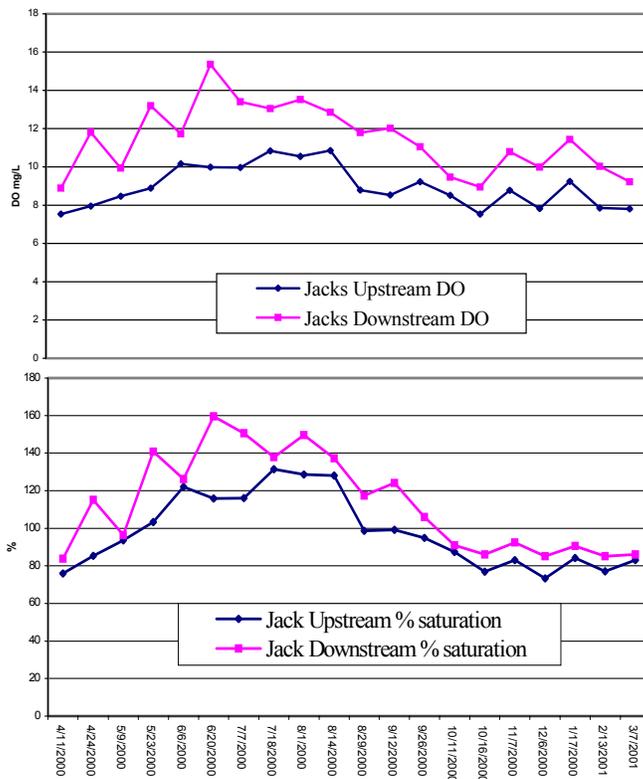


Figure 5. Year two DO and percent saturation concentrations

plant die off, and decay of biomass. The downstream station DO data on Jacks Creek indicate this potential problem when compared to the upstream site (Figure 4 and 5).

Temperature

Jacks Creek is listed on the State of Idaho 1998 303(d) list as not meeting temperature requirements for cold water biota. The prepared TMDL for the Bruneau Subbasin (including Jacks Creek) does not include temperature exceedances at this time.

Over the two year study period the Jacks Creek Up station exceeded the instantaneous cold water biota temperature (22 °C) 12 out of 39 measurements (30%). These exceedances occurred during the summer months of June, July and August. There were five exceedances during the first year of the study and seven during year two

Table 2 Temperature Statistics (°C)

Jacks Creek Temperature Statistics (°C)		
First Year (4/22/99 through 3/7/2000)		
Sites	Jack Creek Up	Jack Creek Down
Mean	18.2	15.1
Median	16.8	14.7
Maximum	25.8	22.8
Minimum	12.2	7.90
St. Deviation	4.58	5.16
Jacks Creek Temperature Statistics (°C)		
Second Year (4/11/00 through 3/7/2001)		
Mean	19.3	14.4
Median	19.6	14.0
Maximum	25.4	21.0
Minimum	11.1	5.4
St. Deviation	4.53	4.39

(Appendix A).

The downstream site (Jacks Creek Down) exceeded the criteria only 3 out of 39 times (8%). The exceedances all occurred in the first year of monitoring during the months of June and July. The water temperature actually cooled from the upstream to the downstream site (on average) approximately 4°C (Table 2). The warmer temperatures at the upstream site may be directly linked to upgradient geothermal springs and irrigation return water from geothermal well water used for irrigation.

Bacteria

Idaho state water quality law (IDAPA 58.01.02.251.01) states that waters designated for primary contact or second-

dary contact shall not contain *Escherichia coli* (*E. coli*) in a single sample greater than 406 organisms per 100 ml; or 576 organisms per 100 ml., respectively.

At the Jacks Creek Upstream site, the primary contact criteria was only exceeded three out of 19 samples (16%)

Table 3. E-coli statistical results (counts/100 ml)

Jacks Creek <i>E-coli</i> Statistics		
First Year (4/22/99 through 3/7/2000)		
Sites	Jacks Creek Up	Jacks Creek Down
Mean	163	862
Median	70	480
Maximum	620	4500
Minimum	10	30
St. Deviation	188	1079
Second Year (4/11/00 through 3/7/2001)		
Mean	146	1301
Median	125	585
Maximum	600	8300
Minimum	9	33
St. Deviation	152	1841

for year one and two out of 20 times (10%) for year 2. For secondary contact two out of 39 samples (5%) exceeded the 576 organism count.

The Jacks Creek Downstream site indicated a major increase in *E-coli* concentrations as compared to the upstream site (Table 3). For the first year, primary contact was exceeded 12 out of 19 times (63%) and secondary contact was exceeded six out of 19 times (32%). Year two exhibited similar trends with primary contact exceedances in 13 out of 20 samples (65%) and secondary contact exceedances in 10 out of 20 times (50%). The lower reach of Jacks Creek is used extensively by waterfowl for resting and feeding which may account for some of the higher *E-coli* concentrations.

Conclusions

Lower Jacks Creek water quality results indicate that water quality impacts have occurred due primarily to anthropogenic activities. The biggest concern is related to excessive TP concentrations entering Jacks Creek causing excessive nuisance aquatic vegetation growth. The nuisance

aquatic growth has a direct impact on dissolved oxygen concentrations which may impact beneficial uses. The excessive growth rate of these plants appears to correlate directly with the excessive TP concentrations within Jacks Creek. There are several possible sources of TP that should be addressed through further evaluation of the system. Some of the possible sources are fish farm effluent, livestock activity near or within the creek, irrigation return waters, and phosphorus from excessive nuisance aquatic growth die off. Fish Farm TP sources have the potential to be the largest total contributor.

The total phosphorus reduction needed to reach the TMDL for TP (0.05 mg/L) would require a phosphorus load reduction of approximately 79 % at both the upper station (Jacks Creek Up) and the lower station (Jacks Creek Down).

During this study there appeared to be no impairment caused by excessive sediment levels. Most of the data indicated that the concentration of TSS is below the criteria outlined by IDEQ in the TMDL document. Also there appeared to be no direct correlation between TSS levels and those of phosphorus.

Over the two years of monitoring, the upstream site exceeded the primary contact requirement for *E-coli* (406 CFU for a one time sample) only 13 % of the time, while the downstream site saw an exceedance rate of 64%. The reason for this increase could be due to cattle activity within the creek or along the banks, irrigation return water influences or the large population of waterfowl that occupy the lower section of Jacks Creek. These excessive levels of *E-coli*, at the lower site, occur during the early spring through summer months and then again during the late fall through the winter. A load reduction for *E-coli* has yet to be addressed by IDEQ for Jacks Creek.

Recommendations

To determine potential sources and their contributions to water quality impairment of Jacks Creek ISDA recommends:

- Identification of source problems by the Bruneau River Soid Conservation District working with local landowners, NRCS, SCC and ISDA staff.
- Evaluation of stream bank conditions for severe down cutting, sloughing and loss of riparian function.
- Evaluation of irrigation water return systems to determine which ones are causing the majority of impacts to the creek. Evaluation of irrigation practices within

the Jacks Creek area.

- Assessment of impacts from livestock operations either confined or otherwise, and their potential impacts on this system.
- Identification of critical areas or critical activities best addressed by implementation of BMPs.
- Evaluation of the permits, effluent, and effects of the two points sources (fish farms) on the nutrient concentration in Jacks Creek. Possible development of additional treatment techniques to lower the organic solids and nutrient concentrations of the two facilities effluent.
- Evaluate the geothermal wells that are used for irrigation for total and dissolved phosphorus concentrations.

References

US Environmental Protection Agency. 1987. Quality Criteria for Water. EPA Publication 405/5-86-001. U.S. Gov. Printing Office, Washington D.C.

Idaho Department of Environmental Quality. 2000. Bruneau Subbasin Assessment and Total Maximum Daily Load of 303(d) Water Bodies.

Appendix A

Year 1 Jacks Creek Upstream

Date	D.O.	Temp	%Sat	Conduct	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coli
4/22/1999	9.64	13.9	93.5	379	274	8.12	14.5	0.32	0.2	0.09	22	6	20	20
5/6/1999	9.46	17.4	98.8	485	351	8.08	6.24	0.54	0.27	0.12	52	13	70	70
5/20/1999	10.63	20.8	118.8	543	394	8.28	7.15	0.54	0.49	0.12	68	20	620	620
6/3/1999	9.03	16.6	92.6	577	418	8.18	8.1	0.39	0.35	0.19	35	14	680	460
6/17/1999	9.4	25.2	114	591	428	8.34	5.21	0.73	0.22	0.19	41	15	180	140
6/30/1999	9.44	24.7	113.5	556	402	8.2	6.5	1.23	0.3	0.2	15	7	320	200
7/15/1999	8.84	22.8	102.8	573	416	7.98	4.5	1.09	0.39	0.28	10	<2	480	100
7/29/1999	6.97	25.8	84.9	559	405	7.85	6.25	1.24	0.34	0.29	41	8	720	400
8/12/1999	7.77	21.7	88.5	685	497	7.96	7.73	1.8	0.27	0.24	16	<2	80	40
8/26/1999	7.17	22.1	82.2	605	438	7.81	8.3	1.14	0.36	0.19	31	6	60	20
9/8/1999	7.64	16.8	78.8	705	511	7.52	6.4	1.32	0.25	0.2	14	8	60	60
9/23/1999	6.41	20.5	71.1	621	449	7.82	6.8	1.24	0.37	0.23	16	4	220	220
10/7/1999	8.38	16	85.1	745	540	7.85	6.76	1.81	0.37	0.23	17	8	30	10
10/22/1999	7.56	13.4	72.5	693	502	8.3	5.5	1.52	0.43	0.29	15	9	40	40
11/17/1999	7.2	15	71.4	573	285	8.01	7.27	1.78	0.4	0.32	19	8	70	40
12/7/1999	8.02	12.7	75.6	658	324	7.94	6.84	1.63	0.38	0.31	13	2	100	100
1/5/2000	8.4	12.2	78.3	695	340	7.84	6.52	1.4	0.4	0.3	15	4	50	50
2/3/2000	8.22	12.8	77.7	665	325	7.95	7.19	1.69	0.35	0.24	18	8	40	10
3/7/2000	8.46	15	84	676	339	8.16	6.86	1.07	0.38	0.17	39	12	560	490
Mean	8.35	18.18	88.64	609.68	402.00	8.01	7.09	1.19	0.34	0.22	26.16	8.94	231.58	162.63
median	8.38	16.8	84.9	605	405	7.98	6.8	1.24	0.36	0.23	18	8	80	70
stdev	1.08	4.58	14.84	88.19	77.16	0.21	2.02	0.50	0.07	0.07	15.82	4.56	248.76	188.32
Maximum	10.63	25.80	118.80	745.00	540.00	8.34	14.50	1.81	0.49	0.32	68.00	20.00	720.00	620.00
Minimum	6.41	12.20	71.10	379.00	274.00	7.52	4.50	0.32	0.20	0.09	10.00	2.00	20.00	10.00

Year 2 Jacks Creek Upstream

Date	D.O.	Temp	%Sat	Conduct	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coli
4/11/2000	7.54	15.8	75.9	631	315	7.68	6.49	0.5	0.29	0.14	38	12	120	80
4/24/2000	7.95	18.8	85.3	548	275	7.64	5.93	0.63	0.38	0.17	75	16	80	80
5/9/2000	8.46	20.4	93.6	611	306	8.18	5.29	0.54	0.16	0.16	43	16	180	120
5/23/2000	8.89	23	103.4	656	305	8.2	5.01	0.34	0.39	0.15	45	18	180	80
6/6/2000	10.16	24.6	122.1	650	326	8.29	5.35	0.47	0.36	0.16	74	26	280	140
6/20/2000	9.98	22.8	115.8	495	246	8.06	4.98	0.33	0.24	0.08	66	17	300	130
7/7/2000	9.96	22.9	116.1	678	340	8.12	5.87	0.47	0.67	0.16	33	13	500	500
7/18/2000	10.84	25.3	131.5	531	270	7.89	6.63	<0.02	0.4	0.07	54	17	320	130
8/1/2000	10.55	25.4	128.7	555	277	8.35	4.56	0.4	0.37	0.14	55	24	730	600
8/14/2000	10.85	23.6	128	517	258	8.25	3.75	0.41	0.34	0.15	49	25	33	33
8/29/2000	8.79	21	98.6	541	275	7.88	3.19	0.78	0.37	0.2	47	18	33	33
9/12/2000	8.54	22.7	99.1	484	239	8.17	4.1	0.69	0.37	0.19	47	21	2000	200
9/26/2000	9.23	16.6	94.8	616	310	8.07	5.17	0.99	0.28	0.19	17	13	470	16
10/11/2000	8.52	16.6	87.4	711	350	8.14	7.18	1.17	0.33	0.22	8	3	66	66
10/16/2000	7.53	16.4	76.8	689	343	8	5.54	1.22	0.37	0.24	21	13	4700	230
11/7/2000	8.77	12.8	83	681	328	8.24	7.07	1.1	0.27	0.21	7	4	130	130
12/6/2000	7.83	12.5	73.4	496	243	7.93	9.61	1.43	0.38	0.24	22	7	330	170
1/17/2001	9.25	11.1	84.1	506	244	7.92	8.5	1.47	0.29	0.22	25	5	66	33
2/13/2001	7.86	14.5	77.1	455	221	7.93	7.64	1.01	0.28	0.18	27	9	23	9
3/7/2001	7.8	18.3	83.1	475	235	8.05	9.12	1.02	0.31	0.17	38	10	150	150
mean	8.97	19.26	97.89	576.30	285.30	8.05	6.05	0.79	0.34	0.17	39.55	14.35	534.55	146.50
median	8.78	19.60	94.20	551.50	276.00	8.07	5.71	0.69	0.35	0.17	40.50	14.50	180.00	125.00
stdev	1.10	4.53	19.39	82.48	40.66	0.19	1.74	0.38	0.10	0.05	19.82	6.76	1073.49	151.64
maximum	10.85	25.4	131.5	711	350	8.35	9.61	1.47	0.67	0.24	75	26	4700	600
minimum	7.53	11.1	73.4	455	221	7.64	3.19	0.33	0.16	0.07	7	3	23	9

**Jacks Creek
Downstream**

Year 1

Date	D.O.	Temp	%Sat	Conduct.	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coil
4/22/1999	11.01	11.3	100.7	571	415	8.12	21.7	0.49	0.28	0.1	100	12	900	820
5/6/1999	13.3	14.9	131.6	1507	1093	8.16	3.72	1.06	0.19	0.08	32	9	140	140
5/20/1999	12.66	17.7	132.9	1289	942	8.12	5.5	0.63	0.22	0.07	40	11	420	240
6/3/1999	9.65	14.5	94.8	1107	802	8.01	16.4	1.4	0.31	0.18	64	15	920	920
6/17/1999	12.4	22.4	142.9	980	708	8.59	9.36	1.26	0.3	0.13	52	12	360	340
6/30/1999	14.13	22.1	161.9	1796	1303	8.3	1.88	2.52	0.17	0.11	8	5	280	160
7/15/1999	12.19	20.1	133.9	2380	1736	8.06	1.29	2.62	0.09	<0.05	11	<2	560	560
7/29/1999	15.47	22.8	179.9	1600	1160	8.26	4.22	1.8	0.43	0.14	16	4	860	480
8/12/1999	13.62	19.7	148.9	1708	1238	8.1	3.92	3.02	0.23	0.19	13	<2	640	400
8/26/1999	13.3	20.4	148	1256	911	8.18	6.3	1.42	0.32	0.17	36	10	560	440
9/8/1999	11.9	13.1	113.5	1514	1096	7.86	4.9	1.91	0.19	0.19	20	8	580	480
9/23/1999	10.34	18.1	109.5	1173	849	7.91	15.7	2.49	0.27	0.19	46	5	1300	1300
10/7/1999	12.25	12.7	115.5	1260	913	8.14	8.2	1.64	0.31	0.19	14	4	150	30
10/22/1999	10.2	9.8	90.3	1046	758	8.58	24.9	1.69	0.16	0.14	34	6	200	160
11/17/1999	10.25	11.3	94	1109	524	8.08	14.9	3.1	0.24	0.24	78	13	2500	2400
12/7/1999	10.9	8.6	93.3	1163	588	8.02	17.8	2.55	0.32	0.22	47	5	4500	4500
1/5/2000	10.86	8.1	91.9	1127	579	8.02	15.3	2.47	0.31	0.24	38	6	540	540
2/3/2000	9.81	7.9	82.7	997	503	8.06	15.93	2.49	0.26	0.16	85	12	2000	2000
3/7/2000	9.74	11	88.4	1394	698	na	14.59	1.9	0.36	0.15	77	13	740	480
mean	11.79	15.08	118.66	1314.58	885.05	8.14	10.87	1.92	0.26	0.16	42.68	8.82	955.26	862.63
Median	11.84	14.70	114.50	1258.00	867.03	8.12	10.11	1.91	0.27	0.16	39.00	8.91	610.00	480.00
stdev	1.67	5.16	28.46	386.92	330.09	0.19	7.08	0.76	0.08	0.05	27.36	3.68	1052.16	1079.48
Minimum	9.65	7.90	82.70	571.00	415.00	7.86	1.29	0.49	0.09	0.07	8.00	4.00	140.00	30.00
Maximum	15.47	22.80	179.90	2380.00	1736.00	8.59	24.90	3.10	0.43	0.24	100.00	15.00	4500.00	4500.00

Jacks Creek Downstream Year 2

Date	D.O.	Temp	%Sat	Conduct	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coli
4/11/2000	8.89	12.6	83.8	1079	540	7.76	13.5	1.08	<0.05	0.025	54	10	230	130
4/24/2000	11.8	14.2	115.1	1463	732	7.92	2.96	0.89	0.25	0.12	41	11	340	340
5/9/2000	9.93	13.8	96.4	1600	800	7.96	3.45	0.6	<0.05	<0.05	23	7	1100	880
5/23/2000	13.2	18.5	140.9	1251	631	8.24	4.72	0.42	0.12	<0.05	14	2	380	300
6/6/2000	11.72	18.7	126.1	1748	889	7.79	1.64	1.3	0.29	0.21	28	6	860	640
6/20/2000	15.35	17.2	159.6	1303	661	7.87	1.61	0.99	0.13	0.07	12	3	530	530
7/7/2000	13.41	21	150.6	1268	633	8.06	3.27	0.96	0.57	0.1	10	6	1100	830
7/18/2000	13.05	18.1	137.9	2180	1150	7.83	1.14	2.81	0.12	0.1	7	2	570	530
8/1/2000	13.51	20.4	149.6	2000	1040	8.06	1.44	1.95	0.09	0.05	<2	<2	300	250
8/14/2000	12.85	18.6	137.2	1892	968	na	1.01	2.11	0.1	0.1	7	3	2200	2200
8/29/2000	11.79	15.1	117.3	2090	1090	7.84	1.4	2.7	0.07	0.07	27	14	1400	1400
9/12/2000	12.01	16.9	124.1	1350	698	na	4.63	1.7	0.24	0.18	23	5	2400	2400
9/26/2000	11.05	13.5	105.9	1159	578	8.13	6.93	1.64	0.18	0.14	34	12	400	230
10/11/2000	9.46	13.6	91	735	366	8.1	20.4	0.81	0.23	0.14	35	5	600	200
10/16/2000	8.95	13.6	86.1	1068	530	8.03	17.9	2.63	0.24	0.14	28	8	8500	33
11/7/2000	10.79	8.3	92.5	1036	527	8.11	14.5	2.06	0.28	0.15	76	11	1500	1500
12/6/2000	9.98	8.3	85.1	991	501	8.09	13.9	8.52	0.34	0.17	53	8	>8300	>8300
1/17/2000	11.44	5.4	90.5	856	438	8.01	14.2	0.89	0.25	0.16	63	11	530	530
2/13/2001	10.04	8.1	85.1	776	385	8.03	9.87	1.41	0.23	0.14	38	10	2400	2400
3/7/2001	9.23	12.2	86.1	847	431	8.05	15.8	1.72	0.34	0.16	60	12	2400	2400
Mean	11.42	14.41	113.05	1334.60	679.40	7.99	7.71	1.86	0.23	0.12	33.32	7.68	1460.00	932.79
median	11.58	14.00	110.50	1259.50	632.00	8.03	4.68	1.53	0.24	0.14	28.00	8.00	860.00	530.00
stdev	1.78	4.39	25.98	448.51	238.61	0.13	6.55	1.72	0.12	0.05	20.25	3.73	1871.55	846.32
Minimum	8.89	5.4	83.8	735	366	7.76	1.01	0.42	0.07	0.025	7	2	230	33
Maximum	15.35	21	159.6	2180	1150	8.24	20.4	8.52	0.57	0.21	76	14	8500	2400

Pierce Drain Upstream

Date	D.O.	Temp	%Sat	Conduct	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coli
5/9/2000	8.96	14.5	88	3830	1910	8.4	1.68	12.6	0.08	<0.05	11	5	700	360
5/23/2000	8.83	17.2	91.6	5350	2690	8.1	1.08	31.9	0.1	<0.05	9	2	2000	1500
6/6/2000	10.58	17.8	110.9	5180	2640	8.06	0.61	29.6	0.07	<0.05	11	2	1600	1000
6/20/2000	10.07	16.9	103.8	2250	1140	8.08	2.3	8.04	0.11	<0.05	20	3	1100	700
7/7/2000	9.16	18.6	97.6	5630	2870	7.96	0.74	35.8	0.96	<0.05	14	4	1300	1300
7/18/2000	9.59	20.2	105.9	2750	1400	7.93	2.77	15.7	0.08	<0.05	13	3	2100	1600
8/1/2000	8.52	20.4	94.6	2600	1350	8.23	2.31	11.2	0.06	0.05	17	6	1400	1200
8/14/2000	8.99	17.1	92.9	4170	2170	8.18	1.72	24.4	<0.05	<0.05	<2	<2	270	270
8/29/2000	8.99	15.4	89.5	2650	1350	8.17	4.16	13.5	<0.05	<0.05	23	5	430	430
9/12/2000	8.49	15.6	85.1	2710	1380	8.1	2.82	12.5	<0.05	<0.05	6	<2	<33	<33
9/26/2000	10.56	8.5	90.5	4130	2130	8.27	2.84	26.3	0.15	0.15	11	5	200	200
10/11/2000	9.64	9.2	84.1	4580	2350	8.28	2.1	25.2	0.07	<0.05	18	<2	200	100
10/16/2000	10.79	7.2	89.1	5760	2990	8.28	1.81	32.9	0.1	0.06	8	3	5100	270
11/7/2000	12.38	2.6	90.9	6070	3080	8.32	0.88	33.1	0.07	0.06	6	2	33	33

Pierce Drain Downstream

Date	D.O.	Temp	%Sat	Conduct	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coli
5/9/2000	9.72	16.6	99.7	2020	1010	8.41	0.5	4.27	0.18	0.09	25	7	920	520
5/23/2000	11.06	19.4	120.2	1251	630	8.31	0.03	1.74	0.26	0.14	16	7	300	200
6/6/2000	10.93	20.9	122.4	1302	642	8.32	0.43	3.3	0.41	0.26	31	8	780	700
6/20/2000	11.35	18.7	121.8	1487	746	8.2	0.34	3.53	0.18	0.07	25	7	600	300
7/7/2000	no sample													
7/18/2000	10.68	20.3	120.5	2000	1030	7.97	0.89	8.09	0.23	0.19	20	2	230	230
8/1/2000	insufficient	water to	collect flows	or water										
8/14/2000	8.63	19.1	93.2	2000	1020	8.22	0.96	8.7	0.1	0.1	47	7	300	300
8/29/2000	9.59	155	96.3	1784	899	8.01	0.46	6.66	0.07	0.07	15	6	170	170
9/12/2000	8.47	16.6	87	1653	826	8.1	0.38	5.11	0.23	0.21	7	3	3500	700
9/26/2000	9.93	11.5	91.3	202	108	8.29	0.11	9.29	<0.05	<0.05	10	4	870	230
10/11/2000	9.68	11.7	89.4	2600	1300	8.24	0.97	10.6	0.71	0.15	274	27	1700	130
10/16/2000	10.16	9.4	89	3940	2000	8.24	2.01	19.6	0.09	0.06	10	4	730	400
11/7/2000	13.61	4.2	104.6	4400	2190	8.35	1.5	20.1	0.07	0.05	13	3	100	100

Fish Farm Effluent

Date	D.O.	Temp	%Sat	Conduct	TDS	pH	Discharge	Nitrate/nitrite	Total-P	Ortho-P	TSS	TVSS	Fecal	E-Coli
8/29/2000	8.78	28.4	113.1	278	137	8.23	2.98	0.15	0.48	0.16	39	30	100	33