Salmon Falls Creek Water Quality Report

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Introduction

Salmon Falls Creek originates in northern Nevada in the O'Neil Basin and drains into the Snake River approximately 11 miles south of Hagerman, Idaho. The Salmon Falls Creek watershed (HUC 17040213) encompasses the Shoshone Basin, Brown's Bench and Twin Falls Canal Company irrigation return flows. Salmon Falls Creek is contained within a deep canyon from the Idaho/Nevada border until it reaches Miracle Hot Springs, just before the confluence with the Snake River. The backwater of the Salmon Falls Reservoir begins a couple of miles north of the Idaho border. Below the reservoir, the majority of Salmon Falls Creek is on BLM land (22 miles) and the rest is on state land (1/8 mile) and private land (23 miles). The Idaho Association of Soil Conservation Districts (IASCD) has been conducting water quality monitoring on Salmon Falls Creek for the Balanced Rock Soil and Water Conservation District (SCD). The data collected will be used to support the Salmon Falls Creek Subbasin Assessment and TMDL due in December 2006 and the Implementation Plan due in 2008.

Background

Historically, stream discharge in Salmon Falls Creek was seasonally influenced by snowmelt in the Shoshone Basin and Northern Nevada. Since Salmon Falls Dam was built in 1934 the lower portion of Salmon Falls Creek has been drastically altered from its historic hydrograph. In 1984, due to a large flood, the Salmon Falls Reservoir was spilled for the first and only time since being built. The hydrograph below the dam is now controlled by the amount of water that seeps from the sides of the dam, springs and groundwater, irrigation return flow and irrigation diversions that pump water out of the canyon.

Below the dam, water quality is minimally impacted by land use practices within the canyon. Most of the impairment of water quality is caused by the dam itself and land uses practices that exist on the canyon rim and surrounding areas. After leaving BLM land the creek runs through 1/8 mile of state land through Balanced Rock State Park. Below the park land ownership in the canyon is private. Land use within the canyon is limited until it opens up at the Snake River Canyon. Miracle Hot Springs is the first establishment in the canyon and is a recreation area. Below the hot springs there are several homes along the creek before the confluence with the Snake River.

Below Balanced Rock State Park there are five agricultural return drains that empty into Salmon Falls Creek. The drains are Drain 3, Drain 4C, Drain 5A, Lateral 10P and Lateral 10S. Current water quality data exists on L10P, L10S and 5A from the Agricultural Research Service (ARS). During the irrigation season water is diverted from the High Line Canal and Deep Creek. During the non-irrigation season water is diverted from Deep Creek into L10P to run a small hydroelectric plant and drains into Salmon Falls Creek.

There are three major pumping stations in the canyon that supply irrigation water to Magic Commons Irrigation District. The first pump is located just below Balanced Rock State Park and pumps geothermal groundwater to the surface. The next two pumps withdraw directly from the creek. The amount of water diverted by these pumps is unknown.

Salmon Falls Creek, from Devils Creek to the mouth, is listed in the 2002 Integrated §303(d)/§305(b) Report for water quality impairment (IDEQ 2006). This stretch is listed for sediment, nutrients, bacteria, and dissolved oxygen. Beneficial uses on this stretch are agricultural water supply, primary and secondary contact recreation, cold water aquatic life and special resource waters. Potential TMDL targets are listed in Table 1.

Table 1. Potential TMDL targets for Salmon Falls Creek.

Pollution	TMDL Target for
Suspended Sediment Concentration (SSC)	Not to exceed 80 mg/L instantaneously
Total Phosphorous (TP)	Not to exceed 0.116 mg/L instantaneously
Bacteria (*E. coli*)	Not to exceed 406cfu/100 mL
Dissolved Oxygen (DO)	> 6.0 mg/L
Temperature (°C) Salmonid Spawning	Not to exceed 13°C (May 1-June 30, Sept. 15-Nov. 15)
Temperature (°C) Cold Water Aquatic Biota	Not to exceed 22°C (June 22 - Sept. 21)

Monitoring Program

Water quality samples were collected by the IASCD twice per month from March through October and once per month from November through February. Water quality data was collected at three sites along Salmon Falls Creek: SF1 at Miracle Hot Springs, SF2 just below Balanced Rock State Park and SF3 at Lilly Grade. The three monitoring sites are shown in Figure 1.

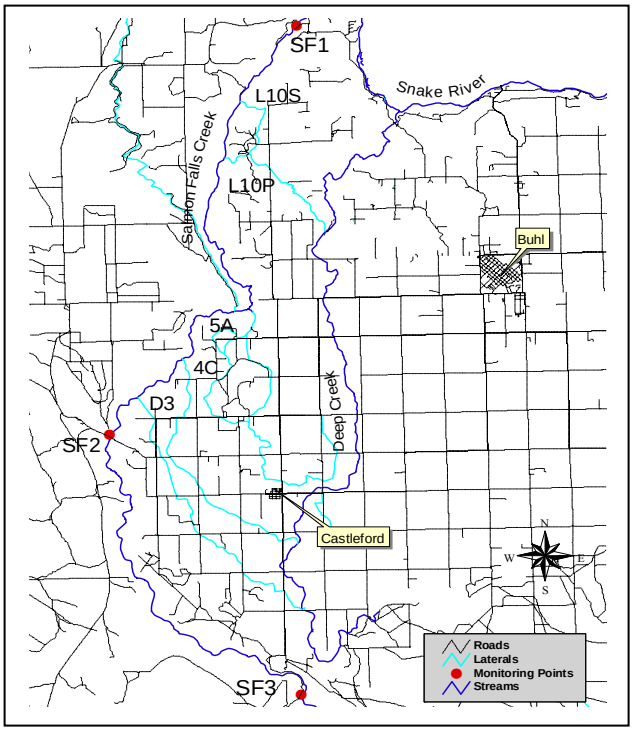

Figure 1. Monitoring locations on Salmon Falls Creek.

Monitoring began in April 2002 and continued through March 2004 at all three sites. The monitoring program resumed in April 2005 and continued though December at SF2 and SF3. SF1 was monitored through February 2006. Parameters sampled were suspended sediment concentration (SSC), total phosphorous (TP), dissolved phosphorous (DP) and *Escherichia coli (E. coli).* Field parameter sampled were stream discharge (cfs), conductivity, total dissolved solids (TDS), pH, dissolved oxygen (DO) and saturation.

Three of the four laterals that drain into Salmon Falls Creek (L10P, L10S and 5A) were monitored by ARS in 2005. These three sites were monitored on a weekly basis with a weekly grab sample. Flow measurements were collected by an automated sampler. Monitoring began in January 2005 on L10P and continued through February 2006. Monitoring on 5A and L10S began in April 2005 and continued through October 2005. Parameters sampled were total suspended sediment, and dissolved phosphorous. Other parameters were sampled but are not pertinent to this study.

Results

Stream Discharge

In most watersheds stream discharge is regulated by precipitation and snowmelt. Because Salmon Falls Creek is highly regulated by the dam, stream discharge variation is controlled by other factors. Stream discharge at SF3 is regulated by the amount of water stored behind Salmon Falls Dam that seeps out of the canyon walls. At SF2, stream discharge is controlled by groundwater influences and springs. Stream discharge at SF1 is controlled by irrigation return flows and diversions during the irrigation season and groundwater and springs during the non-irrigation season.

Stream discharge at SF1 averaged 116.5 cubic feet per second (cfs) from 2002 to 2005. During the irrigation season mean discharge was 94.4 cfs. During the non-irrigation season mean discharge was 134 cfs (Figure 2). Stream discharge at SF2 and SF3 does not fluctuate between the irrigation season and non irrigation seasons. Means discharge at SF2 was 34.3 cfs and 12.1 cfs at SF3 (Figure 3).

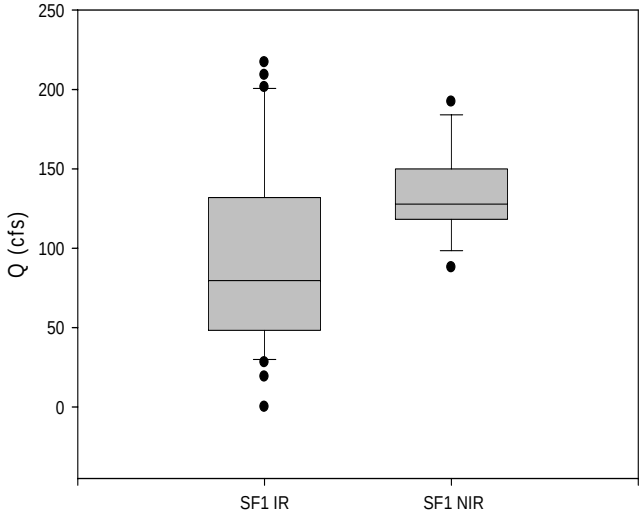

Figure 2. Stream discharge (cfs) at SF1 during the irrigation (IR) and non-irrigation season (NIR).

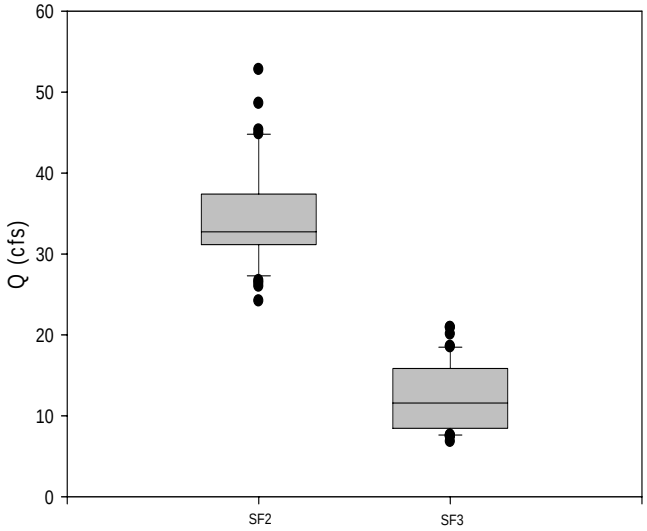

Figure 3. Stream discharge (cfs) at SF2 and SF3.

There are five agricultural return drains that empty into Salmon Falls Creek between SF2 and SF1. Discharge is only known for three of these drains, L10P, L10S and 5A. During the irrigation season, discharge at 5A averaged 5.79 cfs. Stream discharge at L10P averaged

51.2 cfs and 5.02 cfs at L10S during the irrigation season. There are water rights to run a small hydroelectric plant during the non-irrigation season on L10P. During the non-irrigation season discharge on this drain averaged 32.2 cfs. Mean, minimum, maximum and the standard deviation for stream discharge for all the sites and drains are shown in Table 2.

Table 2. Stream discharge (cfs) statistics.

Site	Mean Q (cfs)	Min Q (cfs)	Max Q (cfs)	Std. Dev.
SF1 IR	94.4	19	217	20.55
SF1 NIR	134	87.9	192	14.59
SF2	34.35	24.19	52.78	5.92
SF3	12.1	6.81	20.93	4.19
5A	4.4	0.73	8.76	2.41
L10P IR	51	31.4	62.8	10.92
L10P NIR	30.5	4.3	21.8	15.89
L10S	5.38	0.22	33.5	8.37
Std. Dev.: standard deviation, IR: irrigation season, NIR: non-irrigation season.				

Suspended Sediment Concentration

Suspended sediment concentration (SSC) was measured at the three monitoring locations in 2005. Total suspended sediment (TSS) was measured at these sites in 2002 through 2004 and at the drains in 2005. Because the majority of the sediment in Salmon Falls Creek is fine clay it will be assumed that TSS concentrations and SSC concentrations are comparable.

Suspended sediment concentrations at SF1 averaged 17.43 mg/L (2,416.9 tons/year) during the irrigation season and 15.7 mg/L (3,159.9 tons/year) during the non-irrigation season (Table 3). From the three monitored drains, an average of 218.63 mg/L (3,181.72 tons/year) of sediment is being added to Salmon Falls Creek during the year. Mean sediment concentrations for the 5A drains and L10P drain exceeded the potential TMDL target of 80 mg/L. The potential TMDL target was exceeded for more than 10% of the samples at each of the drains during the irrigation season. During the non-irrigation season the potential target was not exceeded on the L10P drain.

Suspended sediment concentrations at SF2 and SF3 remained relatively constant. Mean SSC at SF2 was 4.9 mg/L (165.3 tons/year) and 2.2 mg/L (26.2 tons/year) at SF3. Although there was little variation in concentration throughout the year, SSC at the two sites was significantly different from each other ($p<0.001$). SSC levels remained well below the expected TMDL target of 80 mg/L instantaneous target or the 50 mg/L monthly target at the three Salmon Falls Creek sites.

Table 3. Suspended sediment concentration (mg/L) statistics and loads (tons/year).

Site	Mean SSC (mg/L)	Min SSC (mg/L)	Max SSC (mg/L)	Std. Dev.	SSC load (t/year)
SF1 IR	17.43	2	115.5	22.7	842.5
SF1 NIR	15.75	2	34.4	10.8	992.2
SF2	4.9	1.8	12.7	2.7	165.3
SF3	2.2	0.4	10.4	1.4	26.2
5A	85.27	5	395	100.7	219.03
L10P IR	93.5	34	220	62.6	2,199.4
L10P NIR	24.2	10	65	14.5	654.9
L10S	49.14	4	200	35	135.39
IR: irrigation season, NIR: non-irrigation season					

Total Phosphorous

The expected target for total phosphorous (TP) is 0.116 mg/L for instantaneous measurements. This level was exceeded for 24% of the samples taken during the irrigation season at SF1. The mean TP level was 0.088 mg/L during the irrigation season (Table 4). During the non-irrigation season the target was exceeded for 20% of the samples and the mean level was 0.075 mg/L. Excessive macrophyte growth was observed during the irrigation season at this site by the IASCD. Dissolved phosphorous made up 48% of TP during the irrigation season and 49% during the non-irrigation season (Figure 5).

Dissolved phosphorous levels (mg/L) were collected by ARS on the agricultural drains.

Total phosphorous concentrations were calculated using the formula:

TP (mg/L) = TSS (mg/L) * 0.001

where 0.001 is the proportion of total phosphorous that is associated with suspended sediment within the agricultural drains (Westerman, 2006). The potential TMDL target was exceeded at the 5A drain and L10P drain during the irrigation season. The mean TP concentration was well below the potential TMDL target at L10P during the non-irrigation season (0.026 mg/L) and just below this target at L10S (0.136 mg/L).

Mean TP levels at SF2 and SF3 were well below the target concentration (0.032 mg/L and 0.039 mg/L respectively). Along with stream discharge and suspended sediment, TP levels were significantly different between these sites ($p<0.001$). Also, as expected, the total phosphorous levels are composed of mainly dissolved phosphorous. At SF2 dissolved phosphorous made up 79% of the total phosphorous and 84% of the total phosphorous at SF3. The dissolved phosphorous concentrations were not significantly different between the two sites. The source of dissolved phosphorous at these two sites is most likely from groundwater inputs.

Table 4. Total phosphorous (mg/L) statistics for Salmon Falls Creek and agricultural return drains.

Site	Mean TP (mg/L)	Min TP (mg/L)	Max TP (mg/L)	Std. Dev.
SF1 IR	0.088	0.025	0.350	0.062
SF1 NIR	0.074	0.025	0.177	0.050
SF2	0.036	0.010	0.220	0.031
SF3	0.039	0.010	0.100	0.021
5A	0.191	0.125	0.581	0.123
L10P IR	0.190	0.010	0.231	0.062
L10P NIR	0.026	0.011	0.065	0.003
L10S	0.136	0.051	0.231	0.055
Std. Dev.: standard deviation, IR: irrigation season, NIR: non-irrigation season.				

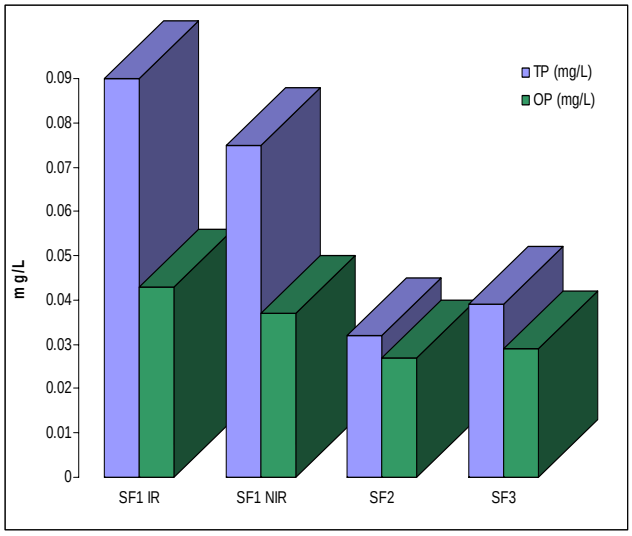

Figure 5. Total phosphorous (mg/L) and dissolved phosphorous (mg/L) comparisons.

Escherichia coli (E. coli)

The *E. coli* target for Salmon Falls Creek is 406 cfu/100mL for primary contact recreation. *E. coli* samples were not collected on the agricultural return drains. At SF1 this target was exceeded for 10% of the samples during the irrigation season and for 7% of the samples during the non-irrigation season. *E. coli* samples were not collected at SF3 until April 2005. The *E. coli* target was not exceeded at either SF2 or SF3. Mean E. coli levels were 79 cfu/100mL at SF2 and 29 cfu/100mL at SF3 (Figure 6).

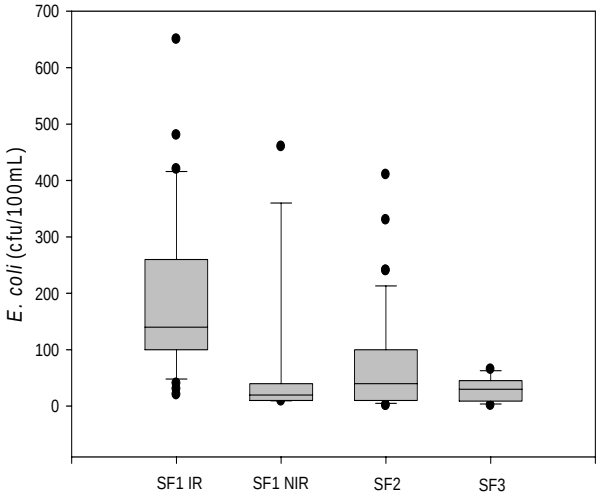

Figure 6. *E. coli* (cfu/100mL) levels for Salmon Falls Creek.

Dissolved Oxygen and Temperature

Dissolved oxygen (DO) levels are not to drop below 6.0 mg/L to meet the water quality standard. The DO levels did not drop below this level at any of the sampling sites during the sampling periods.

Generally, temperature criteria for streams with salmonid spawning (SS) is ≤13 °C (May- June, October- November) and ≤22 °C for cold water aquatic life (CWAL) (June 22- September 21). However, the temperature TMDL for Salmon Falls Creek will be based on canopy cover rather than instantaneous temperature data. Instantaneous temperature will still be reported since canopy cover data has not yet been collected. At SF1 the SS target was exceeded for 75% of the samples and 7% of the samples during CWAL periods. The SS target was exceeded for 77% of samples at SF2. Water temperatures did not exceed 22°C at SF2. At SF3 the SS temperature target was exceeded for 55% of the samples and the CWAL target was exceeded for 23% of the samples. Temperature data is shown in Figure 7.

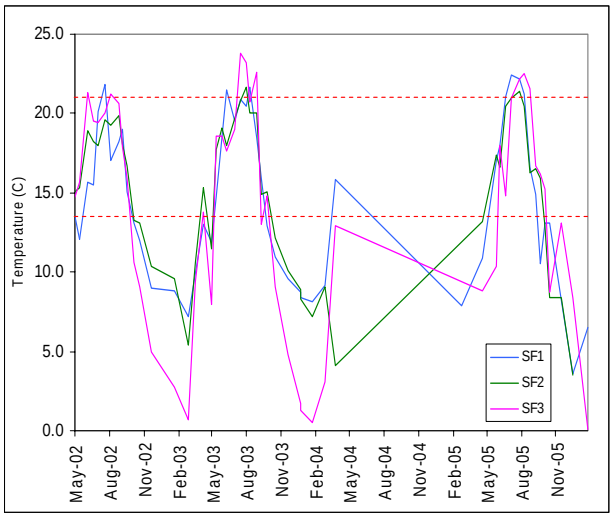

Figure 7. Temperature (°C) for Salmon Falls Creek. The 13 °C target for SS and 22 °C target for CWAL are shown in red.

There are several factors that drive water temperature in Salmon Falls Creek. Salmon Falls Creek lies within a v-shaped valley with limited natural riparian vegetation potential. This limits the amount of shading the stream receives during spring and summer months. There are also numerous geothermal springs along the canyon including a spring at SF2 and at SF1. The agricultural return drains affect water temperature during the irrigation season and groundwater influences affect water temperatures during winter base flow.

Conclusions

Sediment samples at all of the sites on Salmon Falls Creek were well below the potential 80 mg/L TMDL target during the study. However, during the irrigation season excess sediment becomes trapped in thick macrophyte beds and raises the streambed by approximately one foot (observed by IASCD). During the non-irrigation season, as the macrophytes die, sediment is slowly washed out of the stream. Suspended sediment concentrations were well below the potential TMDL target at SF2 and SF3. Two of the three agricultural return drains (5A and L10P) that were sampled exceeded the potential target on average during the study. All of the drains exceed this target for more than 10% of the samples.

The potential instantaneous TMDL target of 0.116 mg/L was exceeded for more than 10% of the samples during the irrigation and non-irrigation season at SF1. Excessive macrophyte growth was also observed at this site. Dissolved phosphorous made up approximately half of the TP throughout the year at this site. Mean TP levels at SF2 and SF3 were well below the TMDL target. Instantaneous TP targets were not exceeded at SF3 and exceeded once at SF2. Mean TP levels were above the 0.116 mg/L target at all of the sampled drains during the irrigation season.

E. coli levels are not to exceed 406 cfu/100mL for instantaneous samples. This target was exceeded twice at SF1 during the irrigation and

once during the non-irrigation season. This target was not exceeded for more than 10% of the samples during either season. Dissolved oxygen is not a limiting factor for Salmon Falls Creek.

Dissolved oxygen levels did not drop below the 6.0 mg/L target during this study. Although water temperature exceeded the salmonid spawning and cold water aquatic life targets for most of the samples, there are many natural factors that potentially cause these exceedances. Water temperature of Salmon Falls Creek is influenced by geothermal springs, groundwater, irrigation return flows, and Salmon Falls Dam. It is recommended that Salmon Falls Creek below the dam should not be listed for dissolved oxygen or temperature.

Recommendations

To reduce sediment and phosphorous levels on Salmon Falls Creek, best management practices (BMPs) should be installed on the agricultural return drains that discharge into the lower section of the creek. Currently, one project is being developed on Drain 4C as a 319 water quality project. This project will eliminate the drain by pumping the tail water into holding ponds where it will be stored and re-used for agricultural purposes. The potential reductions for this project are 622.2 t/year of suspended sediment, 5.4 lbs/day of phosphorous and 27.9 cfu^9/day of *E. coli*. It is not recommended that this BMP be used on all of the drains. Eliminating all of the drains would essentially eliminate the stream discharge in Salmon Falls Creek during the irrigation season in dry years. Other BMPs such as developing large wetlands and settling ponds on the tail drains, planting buffer strips along the canals and developing small settling ponds at the ends of fields will improve water quality. One such wetland has been developed on Drain 3. Unfortunately, water quality data does not exist for this drain. Another potential BMP for the Salmon Falls Creek watershed is to convert surface irrigation to gravity fed sprinkler irrigation. This will reduce the amount of potential erosion from cropland and reduce the amount of water needed to irrigate.

It is also recommended for water quality monitoring to continue on Salmon Falls Creek after BMPs are implemented.

Works Cited

2002 Integrated §303(d)/§305(b) Report. 2006. Idaho Department of Environmental Quality.

Rosen, M., 2005. Wells Pump Back, 319 Water Quality Grant. Idaho Association of Soil Conservation Districts.

Westerman, D., 2006. Upper Snake Rock Conservation Effects Assessment Project. Agriculture Research Service, USDA.