Little Wood River Bypass Water Quality Report

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Introduction

The Little Wood River (LWR) originates in the Pioneer Mountains and drains south to the Big Wood River. It is approximately 106 miles in length with nearly 80 of those miles on the Idaho 303(d) list for sediment, nutrients, bacteria, and temperature (Table 1; Claire 2005).

This report focuses on the area where the LWR, Jim Byrn's Slough (JBS), and Dietrich Canal (DC) meet just south of Richfield, Idaho. Previous monitoring had indicated that the JBS may be adversely affecting the water quality in the LWR below this confluence (Dallon 2005, Monek 2006).

Table 1. TMDL targets for the Little Wood River.

Pollutant	TMDL Target
Suspended Sediment	50 mg/L monthly average
Phosphorous	0.10 mg/L
Escherichia coli	406 cfu/100 mL PCR 576 cfu/100 mL SCR
Temperature	13 °C SS (Oct.- May); 22 °C CWAB (June- Sept.)

PCR: primary contact recreation, SCR: secondary contact recreation SS: salmonid spawning, CWAB: cold water aquatic biota.

A bypass structure was constructed in the late 1990's with State Agriculture Water Quality Program (SAWQP) funds to address this issue. Before the introduction of the structure, clean water was diverted from the LWR into the DC while sediment and nutrient laden water from the JBS discharged directly into the LWR. The addition of the bypass allowed the cleaner LWR water to flow underneath the water flowing from the JBS to the DC, thereby reducing the amount of pollution added to the LWR.

Monitoring conducted in 2004 showed a significant reduction of sediment in the LWR below this junction; however, visual inspection in 2006 suggested that the JBS was continuing to add a considerable amount of pollutants to the LWR.

In response to requests from the Wood River Soil Conservation District (WRSCD), the Idaho Association of Soil Conservation Districts (IASCD) conducted water quality monitoring on the JBS, DC, and LWR during the 2007 irrigation season. Monitoring was

performed to determine the ongoing efficiency of the diversion structure located at the confluence of the three waterbodies.

Suspended sediment concentration (SSC), total phosphorous (TP), dissolved phosphorous (OP), bacteria (*E. coli*), and temperature were gathered from May 2007 until the end of the irrigation season. Nitrate (NO_3) samples were also taken for the first four monitoring periods. Irrigation water stopped flowing on August 17 2007, but resumed for 7 more days commencing on September 10 2007. A description of all monitoring locations is presented in Figure 1 and Table 2.

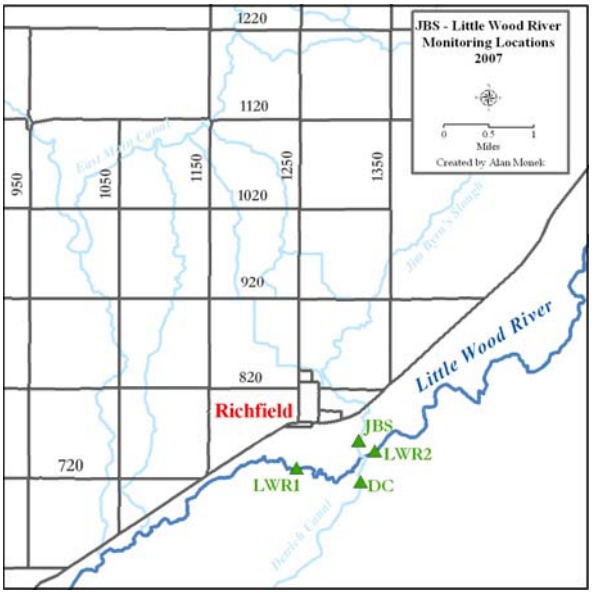

Figure 1. Locations of monitoring sites.

Table 2. Descriptions of monitoring locations.

Site	Description
LWR1	1.5 miles below the JBS-LWR diversion structure at a road crossing
LWR2	50 meters above JBS-LWR diversion structure
JBS	At Highway 26 road crossing
DC	100 meters below LWR point of diversion

Background

Water flows into the bypass structure from the LWR and JBS. Since nearly all the flow of the LWR is diverted for irrigation upstream near Carey, discharge down the LWR is chiefly a result of flows emanating from Silver Creek. Water in the JBS originates from Magic Reservoir and is diverted 17 miles above the bypass structure into the East and West Main canals as well as the JBS. The East and West canals function as a highline canal servicing gravity-fed irrigation needs. Much of this water flows over land, is rerouted for agriculture purposes, and is then returned to the JBS. Thus, the JBS functions as a return drain as well as a feeder source for the DC.

The bypass structure was installed to attempt to keep the cleaner LWR water in the LWR while diverting the sediment laden return water from the JBS into the DC. Before the installation of the bypass structure, irrigation water from the JBS flowed directly into the LWR and continued downstream. Additionally, clean water flowing into the area from the LWR was diverted away into the DC.

The diversion structure consists of pipe routed underground beneath water flowing from the JBS to the DC. Water enters this pipe from the LWR above gradient of the JBS and flows approximately 150 feet below ground before reemerging into the LWR (Figure 2). Notice the contrast of sediment concentration in the LWR (top of picture) and the water coming from the JBS (bottom).

Figure 2. Picture of the LWR-JBS bypass structure. Water from the LWR enters the grate (right) and is diverted downstream underground of the JBS water entering the Dietrich Canal (10 meters to the right of picture frame).

Methods

Water quality samples were collected by grab sampling directly from the source. Sampling sites were located away from obstructions to avoid backwater effects. Except for bacteriological samples, grab samples for each site were composited into a 2.5-gallon polyethylene churn sample splitter. The composite sample was then thoroughly homogenized and poured off into properly prepared sample containers.
For samples requiring filtration (orthophosphate), a portion of sample was transferred into a vacuum unit and pressure-filtered through a 0.45 μm filter.

Nutrient samples that required preservation were transferred into sample containers containing sulfuric acid. Parameters, analytical methods, and holding times are included below (Table 3).

Table 3. Holding times and methodologies.

Parameter	Sample Size	Holding Time	Method
Total Suspended Sediment	1 L	7 days	EPA 160.2
Total Phosphorous	250 mL	28 days	EPA 365.4
Nitrate	250 mL	48 hours	EPA 300.0
Ortho Phosphate	100 mL	24 hours	EPA 365.1
Escherichia Coli	250 mL	30 hours	EPA 1105E

All sample containers were marked to indicate station location, sample identification, date, and time of collection and were placed on ice in a cooler until delivered to Analytical Laboratories in Boise, Idaho for analysis.

Field Measurements

Field measurements for temperature, dissolved oxygen (DO), conductivity, pH, discharge, and a visual assessment of turbidity were performed at each site. All field measurements and other relevant observations about the site (i.e. weather conditions, flow rates, issues that might affect the quality of data) were also recorded. Field measurements, equipment and calibration techniques are listed below (Table 4).

Table 4. Field equipment and calibration standards.

Parameter	Equipment	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55	Centigrade thermometer
Conductance and TDS	Orion Model 115	Conductance standards
pH	Corning Model 313	Standard buffer (7,10)

Stream Flow Measurements

Flow measurements were collected using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenth-depth method (60% of the total depth below water surface) was used when the depth of water was less than or equal to three feet. For depths greater than 3 feet, the two-point method (20% and 80% of the total depth below the water surface) was used. At each station, a transect line was set up perpendicular to flow across the width of the creek. The discharge was computed by addition of the products of the flow cross-sections and the average velocities for each of those sections. Results are expressed in cubic feet per second (cfs). Discharge data for the JBS, DC, and the upper LWR sites were obtained from the local irrigation district Watermaster (M38 2007).

Results

Discharge

Flows on the LWR both below and above the diversion structure, LWR-1 and LWR-2 respectively, were relatively constant (Figure 3). Above the diversion, discharge peaked at 106 cfs early in the season and slowly declined to around 40 cfs by mid-August. Discharge at the lower site on the LWR remained around 40 cfs throughout the monitoring season.

Flow entering from the JBS exhibited the opposite pattern. Discharge generally increased as the season progressed and irrigation demands increased. Much of this water was diverted into the DC resulting in increased flows in the DC.

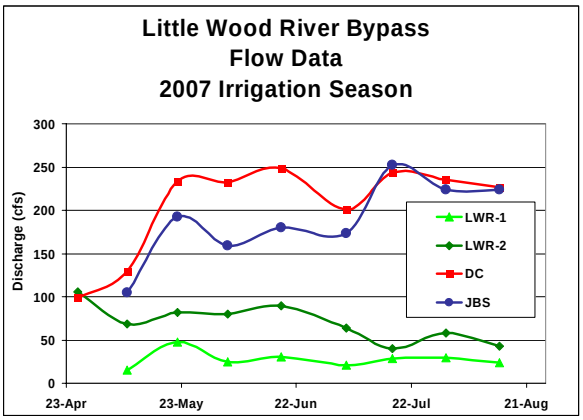

Figure 3. Discharge data for all monitored sites on the days monitoring was performed.

Sediment

Suspended sediment concentrations (SSC) were measured at all monitoring locations for the duration of the irrigation season. The highest concentration for all sites was 39.9 mg/L in the JBS on July 31, 2007 (Figure 4).

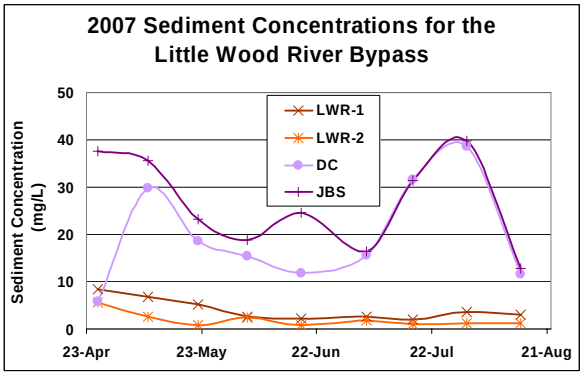

Figure 4. Sediment concentrations for all monitored locations near the LWR bypass structure.

Sediment concentrations at the JBS and DC sites generally started out relatively high, decreased during the middle of the summer, and increased back to their original values later in the irrigation season. This pattern is likely the result of dilution from late April to early May. As increased water demands in the lower part of the system occur during the hottest months, more water is diverted from the Big Wood Canal 17 miles upstream of

the bypass. This water has not had the chance to gather sediment and nutrients since it has been confined to the canal through the area. Additionally, when irrigation needs are high, less diverted water above is likely returned to the canal through drains and laterals above the monitoring location on the JBS.

Average annual sediment concentrations for the JBS and DC were 26.8 mg/L and 19.9 mg/L, respectively. These values are somewhat high; however, they are below the LWR TMDL monthly average target of 50 mg/L (Claire 2005).

SSC values on the LWR were much lower. The average concentration above the diversion was 2.0 mg/L, while the mean sediment level in the river at the lower site below the diversion was 4.1 mg/L. These values would suggest that the high sediment concentrations present in the JBS are having little impact on the LWR directly below the bypass structure.

By multiplying the sediment concentrations gathered at each location by the observed discharge, it is possible to determine the sediment load moving through the system on an annual basis (Figure 5). It appears that nearly all the sediment entering the LWR from the JBS is diverted into the DC.

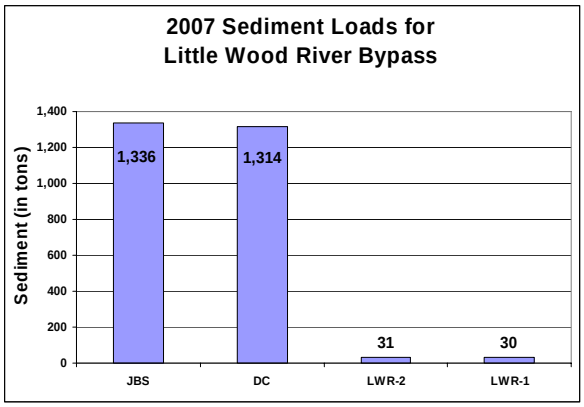

Figure 5. Sediment loads for all monitored locations near the LWR bypass structure.

Sediment concentration remains nearly unchanged between the LWR sites above and below the bypass. Because the lower LWR site is nearly 1.5 miles below the upper site, some sediment may be being deposited within the margins of the channel. This sediment could be susceptible to mobilization and movement downstream during springtime flushes; however, judging by the measure of sediment being transferred from the JBS directly into the DC, the quantity of sediment seems negligible.

Monitoring appears to indicate that the LWR bypass structure is very effective at limiting the amount of sediment into the LWR. If the marginal dilution factor contributed to the DC from the LWR is not considered, the bypass structure has reduced the amount of sediment contributed to the LWR by 98.4%. However, if the sediment in the DC is not reduced by irrigation further down in the system and is making its way back into the LWR, then this sediment may be just being rerouted for a short period. Further monitoring on the lower end of the DC might shed more light on overall effectiveness of the diversion structure.

Phosphorous

Total Phosphorous (TP) and Ortho-phosphorous (OP) were collected as part of this study (Figure 6). As is generally the case, TP concentrations closely paralleled sediment concentration values. When sediment concentrations increased, TP concentrations also increased.

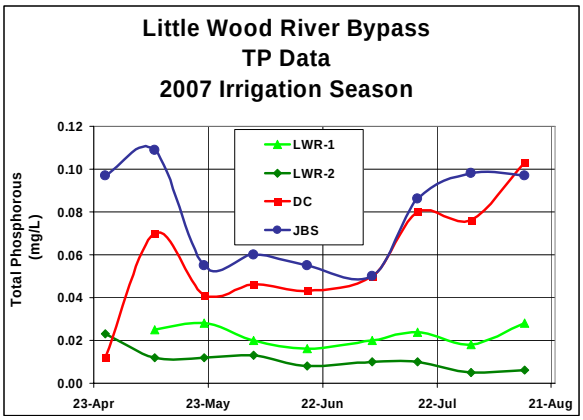

Figure 6. Total Phosphorous (TP) data for all monitored sites.

The highest TP concentration seen in the study was 0.109 mg/L in the JBS on May 9, 2007. The TP target set forth by the LWR TMDL for this stretch of the river is 0.1 mg/L (Claire 2005). The value was observed being exceeded four times, or 44% of the time, in the JBS during the period of monitoring.

TP levels in the JBS and DC hovered around 0.1 mg/L during the beginning of the irrigation season, dropped to 0.06 mg/L in the middle of the summer, and return to roughly 0.1 mg/L at the end of the summer. Once again, this is likely due to dilution of relatively clean canal water during the warmer summer months.

TP levels in the LWR, both above and below the bypass structure, remained below 0.03 mg/L for the entire duration of the study. Values increased roughly 0.015 mg/L from the upper (LWR-2) to the lower site (LWR-1) on the Little Wood River.

Dissolved phosphorous (orthophosphorous) concentrations, often associated with nuisance vegetation in the stream channel, never exceeded 0.03 mg/L for any of the monitored sites. The ratio of dissolved phosphorous to TP ranged from 25-100% in the LWR and 11-52% in the JBS and DC.

The lower concentrations in the canals were undoubtedly due to the high sediment concentration levels and associated TP found in these systems. However, no algae mats or other nuisance vegetation was observed in the LWR below the diversion structure. This would suggest that dissolve phosphorous is not an issue in this reach of the LWR.

Nitrate

Nitrate samples were collected at all locations for the first four monitoring events and sent to the lab. Nitrate levels were consistently low at all locations. Values ranged from non detectable to 0.60 mg/L. Because nitrate concentrations did not seem to be a major issue in the system, sampling for the nutrient was discontinued in June.

Temperature

Because the LWR has been identified as a primary recreation, cold-water salmonid spawning river, stringent Idaho State temperature criteria apply. For such streams, Idaho law requires that instantaneous stream temperature shall not exceed 13° C during critical spawning periods (May 1 – June 30, September 15 – November 15) and shall not exceed 22° C during the remainder of the year.

The temperature criteria were exceeded three out of nine times in the JBS (33%) and four out of nine times at both the LWR sites (44%). These exceedances generally occurred in May and June— when the more stringent spawning criterion is in affect (Figure 7).

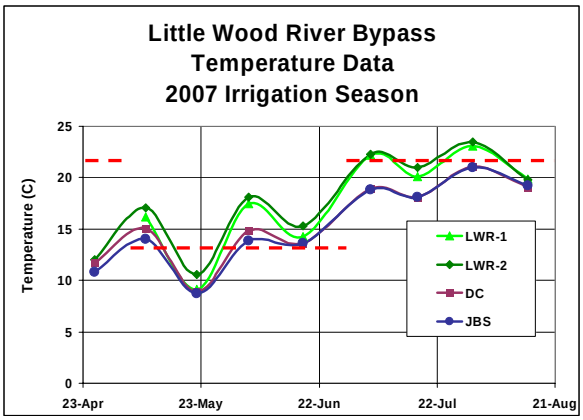

Figure 7. Instantaneous temperature data for all monitored sites. The dashed red line represents appropriate temperature criteria for corresponding times in the year.

It must be noted that these temperature readings should be taken as conservative. Sites were almost always sampled before 1 pm—well before the warmest part of the day. It is therefore likely that water temperatures at these locations exceeded the state standard more often than was documented.

The temperature data suggest that the JBS has little, if any, impact on temperature in the LWR. Water temperatures at the lower LWR site were consistently lower than the upper site. This could be a function of a healthy riparian area between the two sites that results in shading the stream and lowering the temperature of the water. However, above the bypass, the IDEQ and IASCD have independently documented the lack of riparian vegetation in the LWR reaches. It has been suggested in these reports that an improved riparian area could lead to lower water temperatures and improved bank stability for the system (Dallon 2005; Claire 2005).

Dissolved Oxygen

Idaho State water criteria require that Dissolved Oxygen (DO) does not fall below 6.0 mg/L. Below this level, fish become stressed. DO at all sites generally remained well above this concentration (Figure 8). The only exception was at the LWR site above the bypass structure (LWR-2). This site fell below the standard three times (33%) late in the season.

The drop in DO was potentially due to three factors: 1) an increase in water temperatures, 2) a decrease in flow which led to a reduction in water velocity and aeration, and 3) decaying organic matter. However, because corresponding increases in nutrients (i.e. TP) were not found during this period, the impact of decaying aquatic plants may be negligible.

Because water losses its capacity to hold oxygen at warmer temperatures, dissolved oxygen levels often sag with increases in temperature. This makes it difficult for fish and other aquatic life to prosper. Lowering water temperatures, adding debris and/ or constrictions to certain sections of the channel could likely improve DO values in this reach of the LWR.

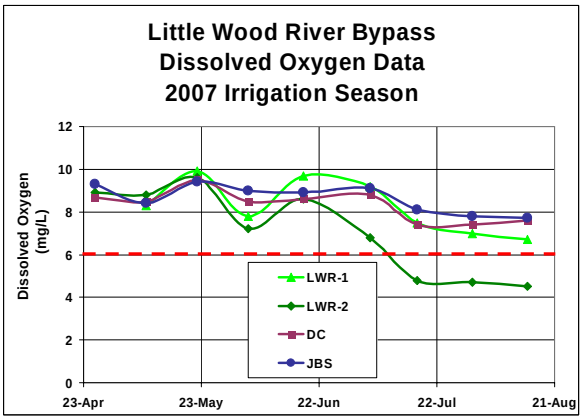

Figure 8. Dissolved Oxygen (DO) data for all monitored sites. The dashed red line represents the state DO water quality standard. Note how the low DO values at LWR-2 corresponded to the highest observed water temperatures seen for the entire irrigation season.

Bacteria

E. coli grab samples were collected at all monitoring locations except on the Dietrich Canal (DC) for the duration of the monitoring season. The highest concentration of bacteria was 890 colony forming units (cfu)/100 mL and was found at the JBS site on May 9, 2007 (Figure 9). This was the only sample that exceeded the Idaho State water quality standard for primary contact recreation (406 cfu/ 100 mL) or secondary contact recreation (576 cfu/ mL).

Bacteria concentrations in the LWR ranged from 1 to 200 cfu/ 100 mL. These values are well below the TMDL targets for this reach of the LWR.

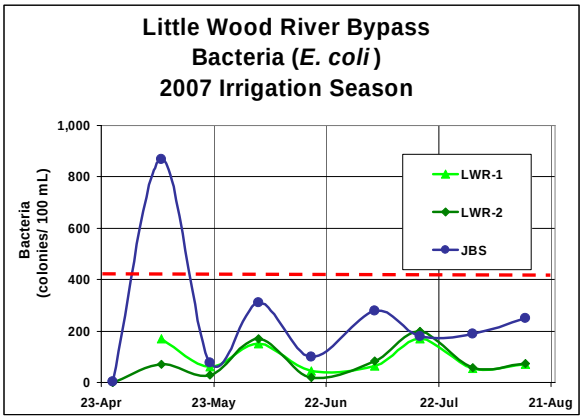

Figure 9. Bacteria (*E. coli*) data for the LWR and JBS. The dashed red line represents the most stringent LWR TMDL bacteria target (e.g. primary contact recreation).

Conclusions and Recommendations

Overall, water quality in the LWR seems good. The installation of the JBS-DC bypass has been very effective in keeping sediment out of the LWR. It has reduced sediment contributions into the river from the JBS by over 98%. However, this success may only be transitory. If the sediment and nutrients entering the DC are merely diverted away from the LWR for a few miles, but then re-enter when the canal rejoins the LWR near Shoshone, then the gains provide by the structure will only benefit a short section of the LWR. Further investigation should be undertaken at the lower end of the DC to clarify the overall effectiveness of the diversion structure.

Nutrients such as nitrogen and phosphorous were slightly elevated in the JBS and DC (both irrigation canals); however, they do not appear to be causing any problems in the LWR. Values for nitrates, TP, and orthophosphorous were substantially lower than targets set forth by the LWR TMDL for the Little Wood River. Nuisance vegetation was never observed in the LWR.

Bacteria issues were nearly non existent. The Idaho state standard for primary contact recreation (406 cfu/100 mL) was exceeded only one time for all monitoring locations. This exceedance was in the JBS canal and is therefore exempt from the targets for bacteria set forth by the LWR TMDL.

On the other hand, temperature and DO seem to continue to be issues of concern. Temperature and DO issues need to be addressed in the reach of the LWR above the bypass. Increased riparian plantings, such as willows and other shade providing vegetation, coupled with keeping cattle away from the stream could go a long way to reducing temperature and improving fish conditions in the river.

Acknowledgements

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