Thorn Creek Water Quality Monitoring Report

February 2008

Alan Monek
Technical Report: AM-TC-08

Idaho Association of Soil Conservation Districts
Twin Falls, Idaho

Introduction

Thorn Creek originates in the Bennett Hills twenty miles north of Gooding, Idaho. The basin drains approximately 42,000 acres of high desert rangeland and farmland. Primary activities within the area include: livestock grazing, farming, cattle feedlots, and recreation. Land ownership in the Thorn Creek basin is principally BLM (80.7%) with private landownership (16.8%) and State of Idaho lands (2.5%).

Thorn Creek is listed on the Idaho 303(d) list for 'unknown' pollutants; however, this listing extends only from the headwaters to Schooler Creek and does not include the lower portion of Thorn Creek investigated by this study. The Big Wood River, which Thorn Creek drains into, is listed for sediment, nutrients, ammonia, bacteria, and flow alteration (Buhidar 2002; Table 1).

Table 1. TMDL targets for the Big Wood River.

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

In 2007, the Natural Resource Conservation Service (NRCS) and the Gooding Soil Conservation District (SCD) requested that the Idaho Association of Soil Conservation Districts (IASCD) collect water quality information in the lower portion of the Thorn Creek watershed. The NRCS has proposed conversion of a significant portion of the lower watershed from surface irrigation to gravity pressurized sprinkler delivery. With the assistance of the NRCS, six sites were selected to provide an overview of water quality within the Thorn Creek watershed.

Monitoring began April 19, 2007 and continued until the end of the irrigation season which ended in mid-September. All sites were monitored bi-weekly. The six sites monitored were: two sites on Thorn Creek, one site on Preacher Creek, one site on the Big Wood River below the confluence with Thorn Creek, and one site on the Highline Canal north of the project area, and one site on a canal that emptied into Thorn Creek from the West just above the upper Thorn Creek site (Table 2). Monitoring on this last site did not begin until June 2. These locations are shown graphically in Figure 1.

Table 2. Monitoring site descriptions.

Site	Location
TC-1	200 meters north of road 1300 South
TC-2	At 1150 South road crossing
PC	At BLM-private ownership boundary, 50 meters below confluence with Portuguese Creek
C-1	At W. County Road crossing 200 meters north of the 1150 N road
C-2	750 meters west of County Line Rd crossing
BWR	400 meters south of confluence with Thorn Creek

Thorn Creek is a perennial stream that flows throughout the year. Preacher Creek, Portuguese Creek, and the two canal sources are the major inputs into the Thorn Creek study area. Discharge in Thorn Creek generally ranged between 0.25 to ten cubic feet per second (cfs) up gradient of the Milner-Gooding Canal. However, due to the seasonal irrigation influence of the Milner-Gooding Canal, discharge in the lower section of Thorn Creek often exceed 100 cfs.

The Big Wood River was never seen flowing above its confluence with Thorn Creek. All water quality impacts witnessed at the Big Wood River monitoring location (BWR) represented water emanating from the lower reach of Thorn Creek.

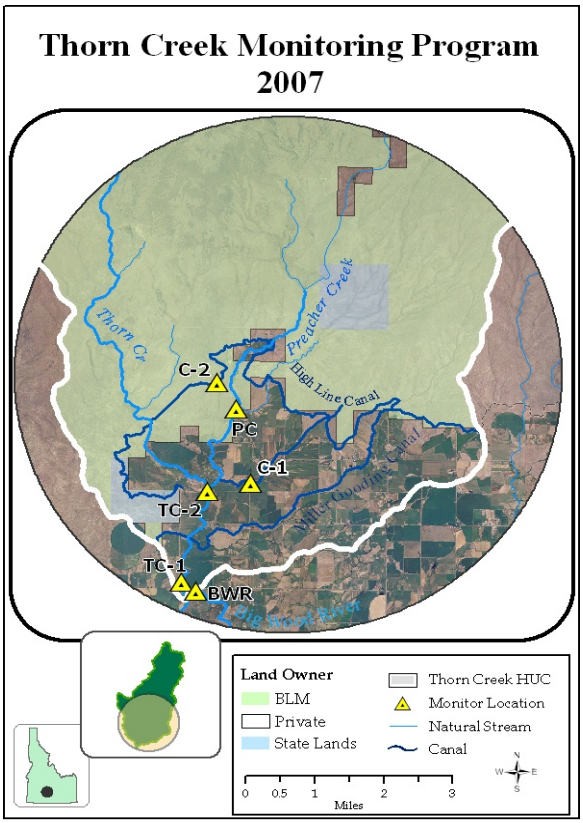

Figure 1. Monitoring locations.

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
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 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).

Results

Discharge

Flow within the Thorn Creek watershed was generally constant (Figure 2). With the exception of Preacher Creek, flow varied very little from the beginning to the end of the irrigation season.

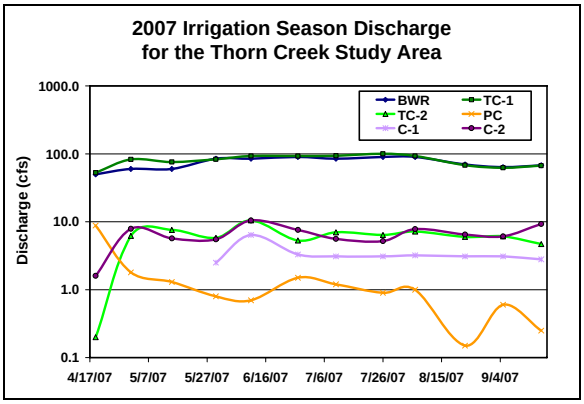

Figure 2. Discharge for all monitoring locations.

This flow pattern is likely because local irrigation practices dominate the hydrologic regime during the summertime. The highest flow observed in the basin was 100.4 cfs at

the lower Thorn Creek site (TC-1) and occurred on July 27, 2007. Nearly 80% of the flow witnessed at TC-1 and 95% of the flow on the Big Wood River at monitoring location BWR was a result of inputs from the Milner-Gooding Canal approximately one mile upstream of TC-1. Although Preacher Creek almost went dry in August, all streams flowed throughout the year.

Sediment

Sediment can negatively impact aquatic life. Extended periods of elevated sediment levels can interfere with the ability of fish to feed, damage fish gills, and reduce growth rates. High levels of sediment can also lead to a decrease in available fish spawning and rearing habitat. Sedimentation of stream channels makes it difficult for fish to reach the insects that reside in the interstitial spaces in the gravels and rocks in the streambed that they rely on for food. Additionally, sediment can be a major contributor of nutrients such as phosphorous.

Sediment concentrations tended to be highest during the springtime in the upper section of the monitoring area, while the lower section of Thorn Creek saw elevated values during July and August (Figure 4). The early season sediment concentration pattern witnessed in the upper section is similar to the patterns seen in natural flow systems. As discharge velocity drops in these systems, the scouring power and ability of water to move sediment drastically decreases. The low springtime sediment concentration in the lower portion of the watershed is likely due to dilution provided by the Milner-Gooding Canal.

The highest observed concentration was 75.1 mg/L at BWR on July 26, 2007 and likely exceeded the BWR TMDL sediment target for the month of July.

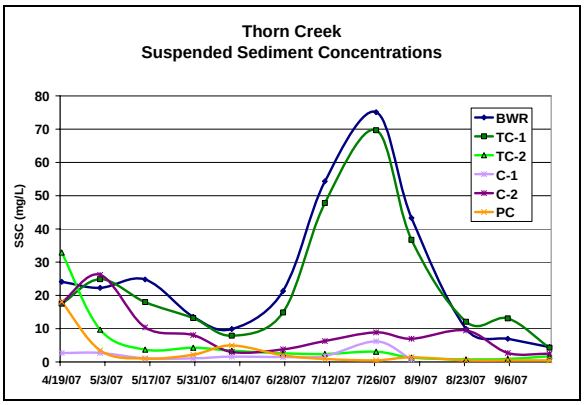

Figure 3. SSC values for all monitoring locations.

Average SSC for TC-2 and PC-1 were quite low at 6.1 mg/L and 1.6 mg/L, respectively. Average SSC at BWR was moderately high with a value of 25.8 mg/L.

Phosphorous

Total phosphorous (TP) is the measurement of all phosphorous, organic and inorganic, contained in a water sample. A portion of this phosphorus is in a dissolved form (orthophosphorous) which can be readily utilized by plants and can lead to impairment of water bodies if the concentration is high enough.
High concentrations of phosphorous can also lead to increases in nuisance algae.

Phosphorous appears to be the most significant water quality issue in the Thorn Creek subbasin. TP values frequently exceeded the target value of 0.10 mg/L set forth by the BWR TMDL.

The highest TP concentration was 0.97 mg/L at PC on June 27, 2007 (Figure 4). This site repeatedly demonstrated high values. Only one out of the twelve samples (8%) was under the BWR TMDL target. This pattern of elevated TP concentrations was mirrored at nearly all monitoring locations; however, the high phosphorous values likely reflect different sources.

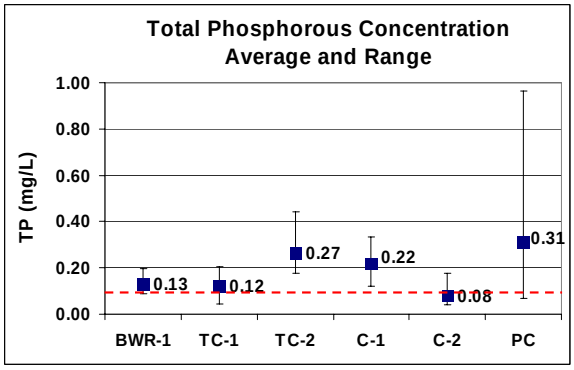

Figure 4. TP values for all monitoring locations. The dotted red line represents the BWR TMDL target concentration.

The quantity of dissolved phosphorous (OP) as a percentage of TP is often indicative of the specific transport processes responsible for moving phosphorous into a waterbody. This ratio varied quite markedly between the upper and lower portions of the watershed. The OP ratio in the highline canal site (C-2) and the lower Thorn Creek station (TC-1) was less than 50%; however, OP at C-1 and TC-2 account for over 80% of TP at each location. This would suggest that phosphorous concentrations in the lower section are primarily a result of high SSC values, while phosphorous in the upper section is principally coming from some other transport mechanism. This other source is likely a combination of two factors.

Irrigated pasture accounts for a significant portion of the land use in the upper Thorn Creek watershed. Previous studies have shown that the application of manure on irrigated pasture can create a buildup of phosphorous in the soil profile (Lory 1999). As water moves through the profile, it absorbs much of the phosphorous within. This water then flows laterally until the water table intersects the surface (e.g. a stream). Cattle may also be a contributor to the phosphorous issue in the upper portion of the watershed. Research has revealed that one 1,000 pound cow can contribute as much as 0.01 pounds of phosphorous to a stream in irrigated agriculture foraging conditions (Allred 2002).

Bacteria

E. coli bacteria did not seem to be an issue at BWR and TC-1; however, bacteria levels that exceeded the BWR TMDL target for secondary contact recreation (526 cfu/100 mL) where often seen at low discharge sites such as TC-2, C-1, and PC. The highest bacteria concentration observed was 2,400 cfu/ 100 mL at TC-2 on April 19, 2007 (Figure 5).

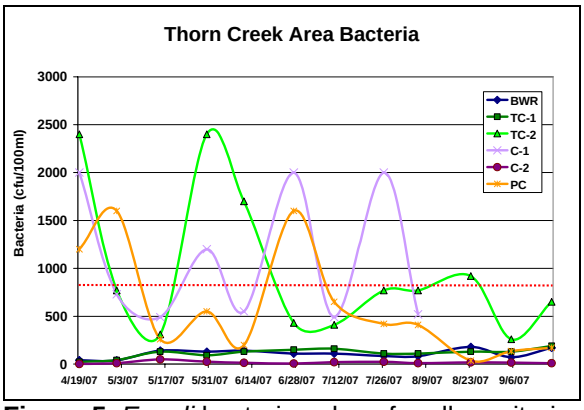

Figure 5. *E. coli* bacteria values for all monitoring locations. The dotted red line represents the BWR TMDL target concentration.

Site C-1 had the highest seasonal average bacteria concentration (1,109 cfu/100 mL) followed by TC-2 (983 cfu/ 100 mL) and PC (603 cfu/100 mL). These significantly elevated levels of bacteria were likely a result of the unabated access of cattle to the waterways in the area and surface runoff from areas where these cattle congregated to nearby waterways.

Temperature

Temperature is a major factor in determining the composition of an aquatic community. It often determines which organisms are present or absent. As temperature increases, the water's ability to hold dissolved oxygen

decreases. This can lead to a stressful environment for fish and make them more susceptible to disease and/or lower their reproductive capacity.

Natural factors that effect water temperature include: climate, shade (from riparian plants, etc), aspect, channel shape, and groundwater interaction. The IDEQ has determined that the instantaneous temperature of any stream listed for cold water biota should never exceed 22 ^{o}C and average daily temperature should stay below 19 ^{o}C (IDEQ 2002). Additionally, because the Big Wood River subbasin is listed for salmonid spawning, a more stringent maximum instantaneous temperature criterion of 13 ^{o}C is mandated for the periods of May 1 – June 30 and September 15 – November 15.

Water temperature exceedances in Thorn Creek and the Big Wood River were quite common. Instantaneous temperature values exceeded the state criteria for more than 40% of the monitoring events at BWR, TC-1, TC-2, C-2, and PC (Figure 6). The majority of these temperature exceedances occurred in the springtime when the more strict salmonid spawning temperature criterion of 13 ^{o}C was in effect.

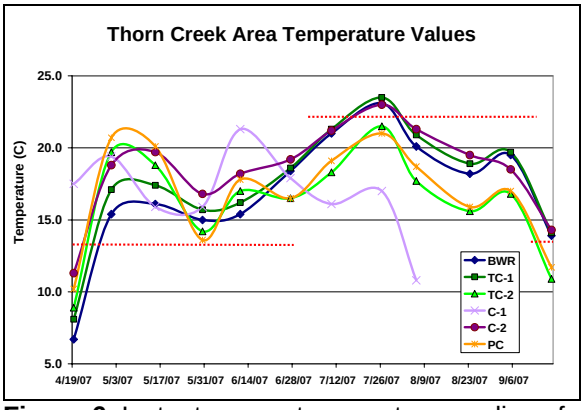

Figure 6. Instantaneous temperature readings for all monitoring locations. The dotted red lines represents the Idaho State temperature standard for a salmonid spawning stream during the appropriate times of the year.

The measured temperatures presented here should be considered conservative. All instantaneous temperature measurements were generally completed before 2:00 PM during the summer months, many hours before the warmest part of the day. It must also be noted that even though high water temperatures in one part of a watershed often impact temperatures farther down in the system, the state water temperature criteria does not apply to canals (i.e. at sites C-1 and C-2).

Conclusions and Recommendations

The largest issues facing water quality in the Thorn Creek watershed appear to be phosphorous, bacteria, and temperature.

Instantaneous phosphorous values dwarfed the BWR TMDL target of 0.10 mg/L repeatedly and the average seasonal values for the nutrient exceeded this target at all but one site in the study area. Average seasonal bacteria concentrations exceeded the instantaneous criterion for secondary contact recreation at C-1, TC-2, and PC. The springtime salmonid spawning temperature criterion was exceeded at every site from May 1 to June 30 and maximum water temperatures recorded in the summertime likely a few degrees below their true highs. Other than improving riparian cover, particularly on the upper section of Thorn Creek, it is difficult to see how water temperatures in this area can be reduced.

The best management practices (BMPs) most likely to succeed in improving water quality in this area include: fencing, offsite watering, nutrient management, and sprinkler conversion.

Fencing and offsite watering of cattle would likely result in better bank stability and lower sediment and nutrient levels. Additionally, limiting cattle's access to

streams and canals could reduce the amount of contaminates from cow manure entering the system. These changes could likely decrease bacteria and phosphorous concentrations.

Changes in fertilizer rate applications and timing could further reduce the amount of phosphorous entering the system. The more efficient use of water such as converting surface-irrigated land to sprinkler irrigation could also limit the amount of phosphorous making its way into the surface water system and improve soil retention.

Acknowledgements

I would like to thank the Gooding SCD and Stephen Thompson for providing input for potential BMP ideas. Kirk Campbell and Gary Bahr have been indispensable technical and editorial resources and important sources of support. I would also like to thank Ken Clark for his inputs and edits to this document.

References

Allred, M. Huyrum Reservoir TMDL, 2002.

Buhidar, B. The Big Wood River Watershed Management Plan, 2002.

Lory, J. Managing Manure Phosphorous to Protect Water Quality, MU Extension-University of Missouri, 1999.

Environmental Protection Agency, Water Quality Criteria 1972, 1973.

Idaho Department of Environmental Quality, Water Body Assessment Guidance-Second Edition, 2002.