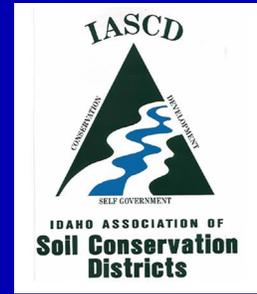


Willow Creek Subbasin Water Quality Monitoring Report Phase I

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Technical Report Summary
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) recently conducted Phase I of a monitoring project in the Willow Creek subbasin in eastern Idaho. Willow Creek is a tributary to the Snake River and enters the river about 1 mile north of Idaho Falls. The subbasin is approximately 647 square miles in size and is located in the Eastside and North Bingham Soil Conservation Districts. Willow Creek originates from streams that drain the east side of the Blackfoot Mountains and the subbasin is bordered on the south and east by the Grays and Caribou mountain ranges. Phase I of this monitoring project concentrated on Willow Creek and six of its tributaries; Meadow, Tex, Homer, Grays Lake Outlet, Birch and Sellars creeks.

The Willow Creek TMDL was written by the Idaho Department of Environmental Quality (DEQ) and approved by the Environmental Protection Agency (EPA) in June 2004. All of the streams included in this report were on the state of Idaho §303(d) list for having water quality limited segments. Every stream except Grays Lake Outlet was listed and received a TMDL for sediment. Sellars Creek was also listed and given a TMDL for stream temperature. Temperature TMDLs were written for Willow, Grays Lake Outlet, Homer, Meadow and Tex creeks because temperature exceedances were documented. A nutrient TMDL was written for Willow Creek because DEQ

observed nuisance aquatic vegetation and low dissolved oxygen levels in parts of the watershed. The beneficial uses designated for these streams are cold water aquatic life (CWAL), salmonid spawning (SS), primary contact recreation, secondary contact recreation, domestic water supply and special resource water.

Table 1. Pollutant targets for stream segments in the Willow Creek subbasin (DEQ 2004).

Pollutant of Concern	Pollutant Targets for the Willow Creek TMDL
Total Suspended Solids (not specified in TMDL)	Best condition (<25 mg/L) Some effects (25-80 mg/L) Definite effects (>80 mg/L)
Total Nitrate + Nitrite	Not to exceed 0.30 mg/L
Total Phosphorus	Not to exceed 0.10 mg/L or 0.05 mg/L (Willow, Meadow)
Temperature (salmonid spawning)	Not to exceed 13°C (May 1- June 30, Sept. 15-Nov. 15)
Temperature (cold water aquatic life)	Not to exceed 22°C (June 22 - Sept. 21)

This monitoring project was initiated at the request of the Eastside Soil and Water Conservation District (SWCD). The project goal was to provide water quality data to districts to allow for identification of potential pollutant sources and to quantify pollutant concentrations in the tributaries. The data will be used to plan implementation of voluntary agricultural best

management practices (BMPs) throughout the Willow Creek subbasin. IASCD has worked cooperatively with Idaho State Department of Agriculture (ISDA), the Eastside SWCD and the North Bingham Soil Conservation District (SCD) to implement this project.

Monitoring Schedule and Site Descriptions

Phase I monitoring began at eight sites in the Willow Creek subbasin in June 2003 and continued through December 2004 (Figure 1). Willow Creek is the primary stream in the subbasin and was monitored at two locations. The downstream monitoring site on Willow Creek (WC1) was located above the Kepp's Crossing bridge and the upstream monitoring site (WC2) was below Pole Bridge.

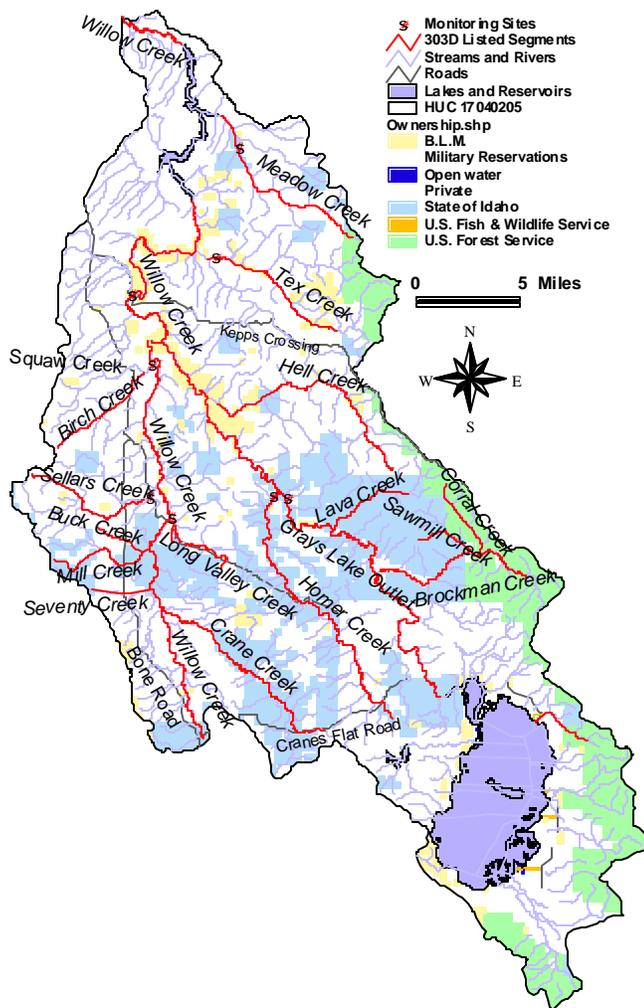


Figure 1. IASCD monitoring locations in the Willow Creek subbasin (Phase I).

Meadow Creek (MC) was monitored approximately two miles before it enters Ririe Reservoir. The Tex Creek (TC) monitoring site was located directly above the confluence with Bulls Fork, upstream of the road. Homer Creek (HC) and Grays Lake Outlet (GLO) were each monitored directly above their confluence. Birch Creek (BC) was monitored directly below the confluence with Squaw Creek, approximately one mile before it flows into Willow Creek. Sellars Creek (SC1) was monitored upstream of Long Valley Road.

IASCD monitored twice a month throughout most of the year and once a month during winter. During each visit, samples were collected for total suspended solids (TSS), total volatile solids, total phosphorous (TP), orthophosphorus, nitrate + nitrite and ammonia. Field measurements were taken for stream discharge, temperature, dissolved oxygen, pH and conductivity.

Results

Discharge

Discharge rates in many of the streams fluctuated seasonally as is common in systems that are largely influenced by snow melt. Stream flow peaked during spring months and declined to base flows for the remainder of the year (Figure 2).

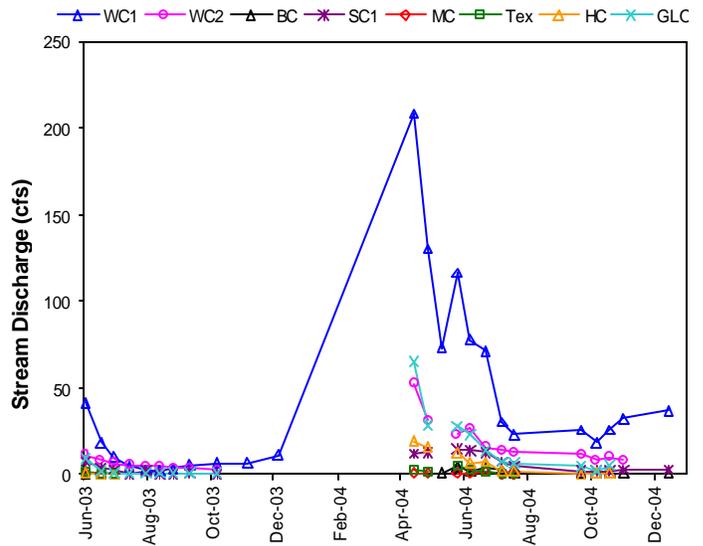


Figure 2. Stream discharge (cfs) at the eight monitoring sites in the Willow Creek subbasin.

Discharge rates were highest at Willow Creek at Kepp's Crossing (WC 1) and lowest in Meadow Creek

(Table 2). Stream flows increased significantly from the upper Willow Creek site to the lower site ($p = 0.02$). Grays Lake Outlet was the largest tributary to Willow Creek that was monitored. Stream discharge was significantly greater in 2004 than in 2003 at the Willow 1, Willow 2, Sellars, Homer and Grays Lake Outlet sites (Figure 3, $p = 0.046$). In 2003, water quality sampling was limited in Meadow, Tex, Homer and Birch creeks because these streams ceased to flow by the end of June.

Table 2. Mean, minimum and maximum stream discharge (cfs) and 95% confidence intervals (CI).

Stream	Mean (cfs)	+/- 95% CI	Min (cfs)	Max (cfs)
Willow 1	41.09	20.17	1.84	208.98
Willow 2	13.14	5.28	2.79	52.12
Meadow	0.57	0.29	0.05	1.45
Tex	1.71	0.99	0.08	5.21
Homer	5.39	3.67	0.33	13.03
Grays Lake	10.51	7.22	2.16	27.12
Birch	1.54	0.71	0.08	4.47
Sellars 1	5.10	2.20	0.08	15.05

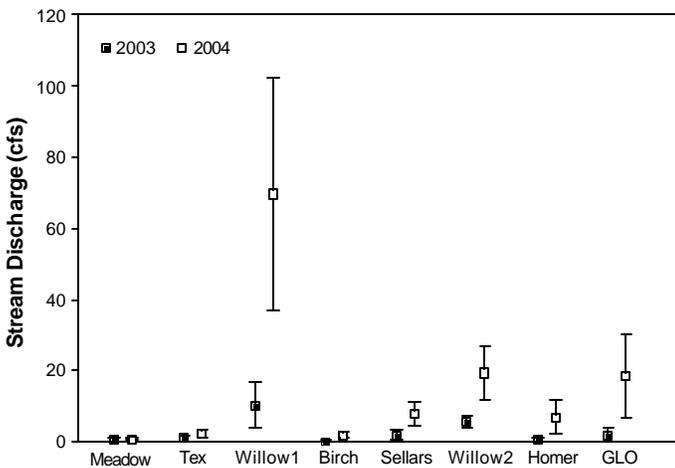


Figure 3. Comparison of mean (\pm 95% CI) stream discharge rates (cfs) in 2003 and 2004 at the eight sites.

Total suspended solids

Total suspended solids (TSS) concentrations in the streams fluctuated on a seasonal basis. As is common in snowmelt dependent systems, TSS levels increased during spring runoff events and declined to low levels throughout the rest of the year at most sites (Figure 4). The one exception to this was Birch Creek, which experienced high TSS levels throughout the year. TSS

concentrations at Tex, Homer, Sellars, Willow 1 and Willow 2 were low and did not exceed the 25 mg/L more than 10% of the time (Table 3). Of the sites that exceeded the target more than 10% of the time, Birch Creek experienced the highest suspended sediment rates.

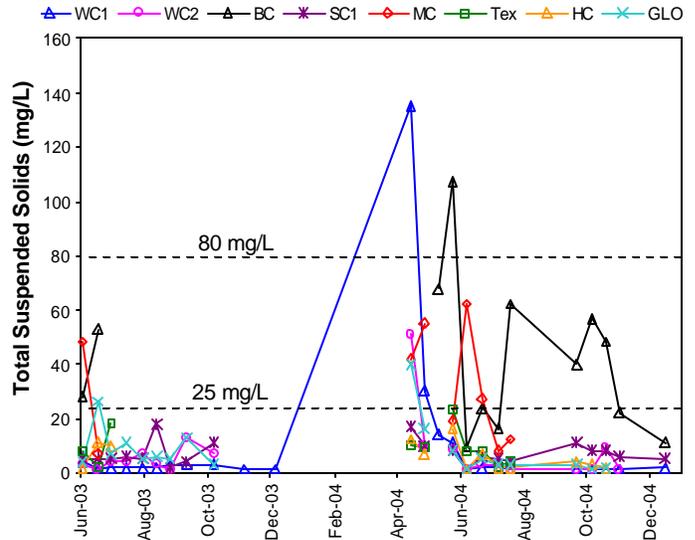


Figure 4. Total suspended solids (TSS) measured at the eight monitoring sites from June 2003 to December 2004. The horizontal dashed lines represent the DEQ targets of 25 and 80 mg/L.

Mean TSS concentrations at the Meadow and Birch Creek sites were above the DEQ target of 25 mg/L (Table 3). TSS levels in Meadow and Birch creeks were significantly higher than the other six streams ($p = 0.04$), but were not different from each other. On average, Willow, Sellars, Tex, Homer and Grays Lake Outlet creeks experienced relatively similar TSS concentrations and did not exceed the water quality target.

Table 3. Mean TSS concentrations (mg/L), 95% confidence intervals (CI) and percent of samples that exceeded the 25 and 80 mg/L targets.

Stream	Mean (mg/L)	+/- 95% CI	% over 25 mg/L	% over 80 mg/L
Willow 1	9.4	11.0	8%	4%
Willow 2	6.6	4.8	5%	0%
Meadow	31.1	13.8	56%	0%
Tex	9.2	4.2	0%	0%
Homer	6.1	2.6	0%	0%
Grays Lake	8.5	4.4	11%	0%
Birch	41.9	15.2	62%	8%
Sellars 1	7.1	1.8	0%	0%

Total phosphorus

Total phosphorus (TP) concentrations at the eight sites fluctuated throughout the year (Figure 5). Across sites TP levels were highest during the spring and early summer months, with the majority of high TP measurements occurring in April and June. TP concentrations typically declined during fall and winter months. With the exception of Birch Creek, TP concentrations were low at the sites monitored. All of the samples collected from Birch Creek were above the target for TP. Willow and Meadow creeks drain directly to Ririe Reservoir and therefore have a lower TP target (0.05 mg/l). They often exceeded the target, but values were not extremely high.

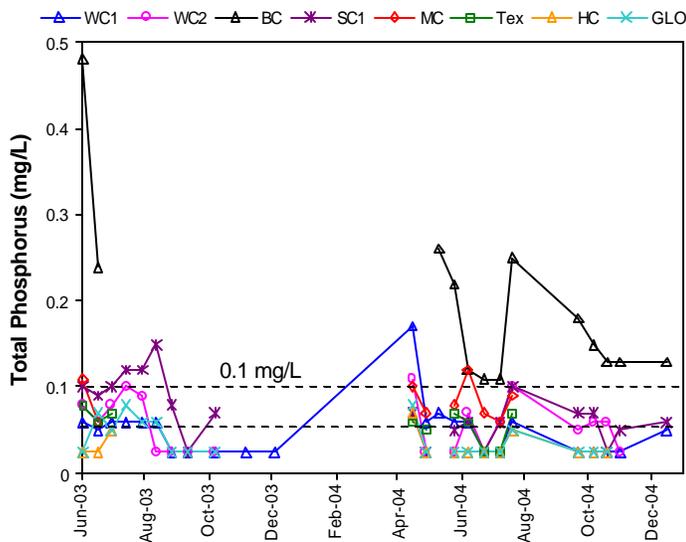


Figure 5. Total phosphorus (TP, mg/L) measured at the eight sites from June 2003 to December 2004. The horizontal dashed line represents the DEQ target of 0.1 mg/L.

On average, TP concentrations at Birch Creek were significantly higher than the other sites ($p < 0.001$). Average concentrations at the Tex, Homer, Grays Lake Outlet and Sellars creek sites were well below the DEQ target (Table 4), but differences between monitoring sites were observed. Tex Creek experienced higher TP levels than the Homer and the Grays Lake Outlet sites ($p = 0.034$), but not different from the Sellars or Willow Creek sites. On average the Meadow and Willow Creek sites met or slightly exceeded the target and TP did not differ significantly between the two Willow Creek sites.

Table 4. Mean TP concentrations (mg/L), 95% confidence intervals (CI) and percent of samples that exceeded the 0.1 mg/L target.

Stream	Mean (cfs)	+/- 95% CI	% over 0.1/0.05 mg/L
Willow 1	0.05	0.01	46%
Willow 2	0.06	0.01	50%
Meadow	0.08	0.01	100%
Tex	0.06	0.01	0%
Homer	0.03	0.01	0%
Grays Lake	0.04	0.01	0%
Birch	0.19	0.06	100%
Sellars 1	0.07	0.01	14%

Temperature

Instantaneous stream temperatures at the eight sites exhibited a seasonal pattern. As expected, temperatures were highest during summer months and declined during fall and winter (Figure 6). Temperature measurements rarely exceeded the target for cold water aquatic life (CWAL, = 22°C) during the project. Grays Lake Outlet and Willow 2 were the only sites where exceedances were observed during CWAL periods (Table 5). Conversely, there were numerous exceedances of the temperature target during salmonid spawning (SS) periods (= 13°C). All streams except Meadow Creek experienced elevated temperatures during SS periods and most exceedances were detected during the end of spring spawning (June).

Average stream temperatures at the eight sites were below the CWAL target and no significant differences were observed between sites. During the critical period for salmonid spawning, average stream temperatures in Grays Lake Outlet and Homer creeks exceeded the target of 22°C. SS temperatures in Homer Creek were significantly higher than those recorded in Meadow Creek ($p = 0.04$), but no other differences were recorded between sites. The majority of temperature exceedances (63%) were recorded during the 2003 sampling and were likely influenced by low stream flows during that year. Analysis of 2004 data only revealed that average stream temperatures in Homer Creek only slightly exceeded the target (13.2°C) and were below the target in Grays Lake Outlet (12.4°C).

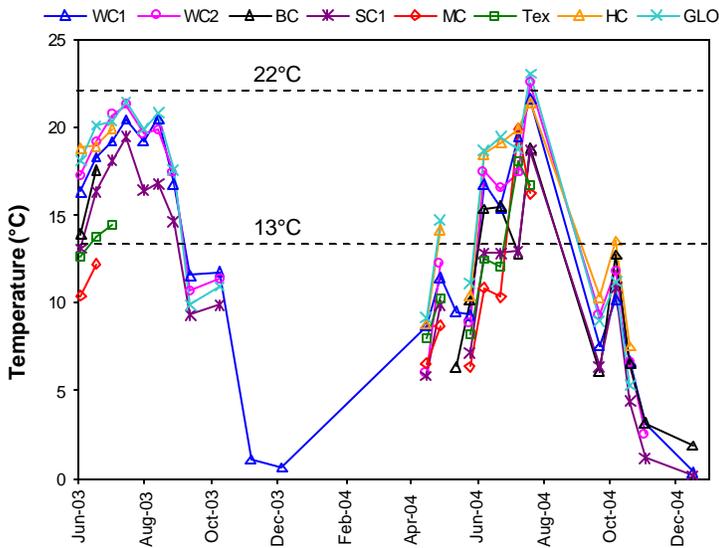


Figure 6. Stream temperature measured at the eight sites in the Willow Creek subbasin from June 2003 to September 2005. The horizontal dashed lines represent the DEQ target for cold water aquatic life (22°C) and salmonid spawning (13°C).

Table 5. Mean stream temperatures, 95% confidence intervals (CI) and the percent of samples that exceeded the CWAL and SS targets.

Stream	Cold Water Aquatic Life		
	Mean (°C)	+/- 95% CI	% over 22°C
Willow 1	17.2	2.8	0%
Willow 2	17.5	2.7	10%
Meadow	15.5	5.5	0%
Tex	15.3	2.6	0%
Homer	18.1	3.9	0%
Grays Lake	18.0	2.9	10%
Birch	13.3	5.3	0%
Sellars 1	14.5	2.6	0%
Salmonid Spawning			
Stream	Mean (°C)	+/- 95% CI	% over 13°C
Willow 1	11.2	3.1	38%
Willow 2	12.9	3.4	45%
Meadow	10.0	1.9	0%
Tex	12.3	1.7	33%
Homer	15.2	3.1	67%
Grays Lake	14.4	3.4	50%
Birch	10.7	3.1	40%
Sellars 1	10.3	3.0	27%

Nitrogen

Nitrogen (nitrate + nitrite, mg/L) concentrations at the eight monitoring sites fluctuated throughout the year, but did not follow a seasonal pattern (Figure 7). Nitrogen levels were highest in Birch Creek and at sites in the upper subbasin (Willow 2, Sellars). These sites exceeded the target of 0.3 mg/L 45-95% of the time. Measurements from the Willow 1, Meadow, Tex, Grays Lake Outlet and Homer sites rarely, if ever, exceeded the water quality target.

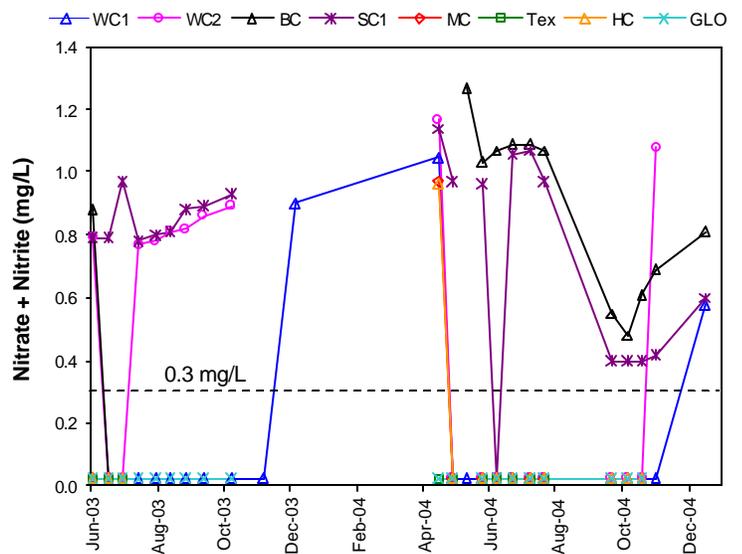


Figure 7. Nitrogen levels (nitrate + nitrite, mg/L) measured at the eight sites in the Willow Creek subbasin from June 2003 to December 2004. The horizontal dashed line represents the DEQ target of 0.3 mg/L.

Average nitrogen concentrations at Willow 2, Sellars and Birch creeks exceeded the DEQ target (Table 6) and were significantly higher than the remaining five sites ($p = 0.029$). Nitrogen levels declined significantly from the upper to the lower Willow Creek site ($p = 0.014$). Birch and Sellars creeks had significantly higher nitrogen levels compared to the Willow 2 site ($p = 0.005$). Nitrogen levels at the Meadow, Tex, Grays Lake Outlet, Homer and Willow 1 sites were similar and well below the target.

Table 6. Mean nitrate + nitrite concentrations, 95% confidence intervals (CI) and percent of samples that exceeded the 0.3 mg/L target.

Stream	Mean (cfs)	+/- 95% CI	% over 0.3 mg/L
Willow 1	0.13	0.11	13%
Willow 2	0.41	0.20	45%
Meadow	0.13	0.21	11%
Tex	0.03	0.00	0%
Homer	0.10	0.14	8%
Grays Lake	0.03	0.00	0%
Birch	0.82	0.19	92%
Sellars 1	0.76	0.12	95%

Conclusions

The seasonal elevation of total suspended solids and total phosphorus is common in snowmelt dependent systems. Despite the seasonal fluctuations, TSS levels were often low at all eight sites. The majority of measurements from Birch and Meadow creeks did exceed the 25 mg/L target, but the 80 mg/L target was rarely exceeded. Birch Creek did not exhibit the seasonal pattern observed in other streams in the subbasin. Instead Birch Creek experienced elevated TSS levels during spring runoff and again during late summer. TP concentrations were not extremely high within the subbasin, although exceedances were often detected. Again, Birch Creek exhibited a peak in the spring and again in late summer. Willow and Meadow creeks exceeded the TP target 46-100% of the time, but average concentrations were not very high indicating that exceedances were numerous but slight. Efforts to limit the input of sediment (and consequently phosphorus) during high flow events should be made by implementing sediment reduction BMPs in the subbasin such as riparian buffers and grazing management. Investigation of land use practices in the Birch Creek subwatershed could help to explain the elevated TSS and TP concentrations during the summer and early fall months.

Stream temperatures were elevated above the target during salmonid spawning periods, but the data collected in 2003 were largely responsible for the number of exceedances. Across sites, 69% of temperature measurements collected during 2003 exceeded the SS target compared to only 20% in 2004. Elevated stream temperatures are of concern in Homer, Grays Lake Outlet and Willow creeks and

could be reduced by increasing the amount of woody vegetation in the riparian zone.

Elevated nitrate levels are a common occurrence in Birch Creek and sites in the upper Willow Creek subbasin. All but one of the samples we collected from Birch and Sellars creeks exceeded the target and the exceedances were often considerable. The upper Willow Creek site, which is upstream of the confluence with Sellars Creek, also experienced elevated nitrogen levels. Conversely, nitrate levels were low at sites in the lower subbasin. The source of nitrogen in the upper subbasin may be related to land use practices or natural background levels. The upper Willow Creek subbasin is largely impacted by livestock grazing and to some degree by cropland. These historic and current impacts may have resulted in elevated nitrate levels over time. The high nitrate levels in the upper reaches of the subbasin may also be related to groundwater inputs. Nitrates move readily in groundwater and may be entering surface waters via groundwater springs.

Attempts to decrease nitrogen inputs in the upper Willow Creek subbasin may benefit the system. Nuisance aquatic vegetation was observed at the Willow 1 site (DEQ) and in Sellars Creek (personal observation), indicating that current nutrient levels may be impairing beneficial uses. Efforts to decrease nitrogen levels in the stream could be made by conducting grazing management planning and constructing fence to exclude livestock from the riparian zones.

Recommendations

The results of phase I of this monitoring project helped to identify water quality limited streams in the subbasin. Continued water quality monitoring is recommended, but with the following modifications.

Birch Creek exhibited the poorest water quality of the streams monitored. Suspended sediment and nutrient levels were highest in Birch Creek and are likely the result of land use practices such as livestock grazing. It is recommended that monitoring continue on Birch Creek and adding a site on Squaw Creek, a tributary to Birch Creek, to determine its contribution to the Birch Creek pollutant load.

Sellars Creek consistently exceeded the nitrate target and it is recommended that a site be added above Bone

Road to better pinpoint the source of nitrogen in the stream.

It is unclear from the elevated nitrate levels at the Willow 2 site whether the nitrogen source is on Willow Creek or on one or more of its tributaries. There are a number of 303(d) listed streams in the upper subbasin that have not been monitored. Of those, it's recommended that monitoring be conducted on Mill and Seventy creeks as well as adding an upper Willow Creek site to help identify the source of nitrogen in the upper subbasin.

Meadow Creek often exceeded sediment and phosphorus targets. DEQ cited road and streambank erosion as the principal sources of sediment in the creek and implementation of BMPs directed at sediment are likely to reduce phosphorus loads to the stream. It is recommended that monitoring be discontinued on Meadow Creek.

Grays Lake Outlet, Homer and Tex creeks exhibited relatively good water quality and it is recommended that monitoring on these sites be discontinued.

Acknowledgements

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Literature Cited

Department of Environmental Quality (DEQ). 2004. Willow Creek Subbasin Assessment and TMDLs. Idaho Falls, Idaho.