Medicine Lodge Subbasin Quality Monitoring Report

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Technical Report Summary
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) recently completed a monitoring project in the Medicine Lodge subbasin in eastern Idaho. Medicine Lodge Creek originates from streams that drain the southern slope of the Beaverhead Mountains along the Continental Divide. The subbasin is approximately 900 miles in size and is located in Clark and Jefferson counties. Medicine Lodge Creek sinks into the ground before ever reaching another water body and along with other subbasins in the area, is referred to as the sinks drainage. This monitoring project concentrated on Medicine Lodge Creek and two of its tributaries; Edie and Irving Creeks.

The Medicine Lodge TMDL was written by the Idaho Department of Environmental Quality (DEQ) and approved by the Environmental Protection Agency (EPA) in February 2003. Medicine Lodge, Edie and Irving creeks were listed on the state of Idaho's §303(d) list for having water quality limited segments. Medicine Lodge Creek was listed from Spring Creek Hollow to the town of Small for flow alteration, sediment and temperature. Edie and Irving creeks were both listed for habitat alteration, nutrients and sediment. Additionally, temperature TMDLs were written for Edie and Irving creeks because temperature exceedances were documented. Nutrient TMDLs were not written because DEQ did not observe nuisance aquatic vegetation in the subwatersheds. The numeric targets used in this report to evaluate nutrient concentrations reflect the regional DEQ targets for nitrogen and phosphorus. 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 Medicine Lodge subbasin.

Pollutant of Concern	Pollutant Targets for Medicine Lodge TMDL
Total Suspended Solids	Not to exceed 80 mg/L, regardless of season
Total Nitrate + Nitrite	Not to exceed 0.30 mg/L
Total Phosphorus	Not to exceed 0.10 mg/L
Temperature (salmonid spawning)	Not to exceed 13°C (May - 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 Clark Soil Conservation District (SCD). The project goal was to provide water quality data to the District 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 Medicine Lodge subbasin. IASCD has worked cooperatively with Idaho State Department of Agriculture (ISDA) and the Clark SCD to implement this project.

Monitoring Schedule and Site Descriptions

Monitoring began at five sites in the Medicine Lodge subbasin in May 2003 and continued through December 2004 (Figure 1). Medicine Lodge Creek is the primary stream in the subbasin and begins at the confluence of Warm and Fritz creeks.

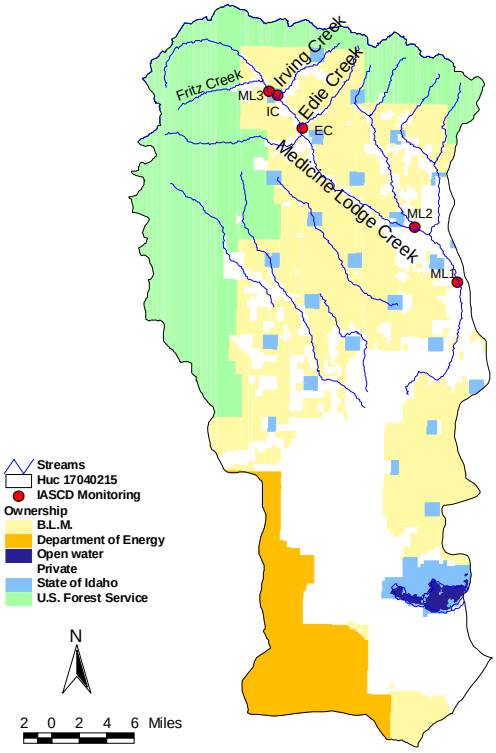

Figure 1. IASCD monitoring locations in the Medicine Lodge subbasin.

The downstream monitoring site on Medicine Lodge (ML1) was located near the town of Small, the next monitoring site (ML2) was directly above the confluence of Middle Creek and the uppermost site (ML3) was located below the confluence with Fritz Creek, but above a major spring development. Much of the land adjacent to the creek is privately owned.

Edie Creek (EC) drains to Medicine Lodge Creek approximately 7.5 miles from its head waters. Edie Creek flows through BLM land for 5.5 miles before entering private land. The drainage is primarily used for grazing livestock (IDEQ 2002). Edie Creek was monitored directly upstream of Medicine Lodge Road.

Irving Creek (IC) flows through USFS and BLM land for approximately 3.5 miles before it enters private land and flows for 3 more miles before the confluence with Medicine Lodge Creek. The land in the Irving Creek watershed is primarily used for grazing with a small amount of farming along the creek (IDEQ 2002). Irving Creek was also monitored upstream of Medicine Lodge 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). Edie Creek was the exception to this trend. Discharge in Edie Creek was relatively constant throughout the year. The upper Medicine Lodge Creek site experienced a seasonal trend with peak flow during spring runoff in 2004, but not in 2003.

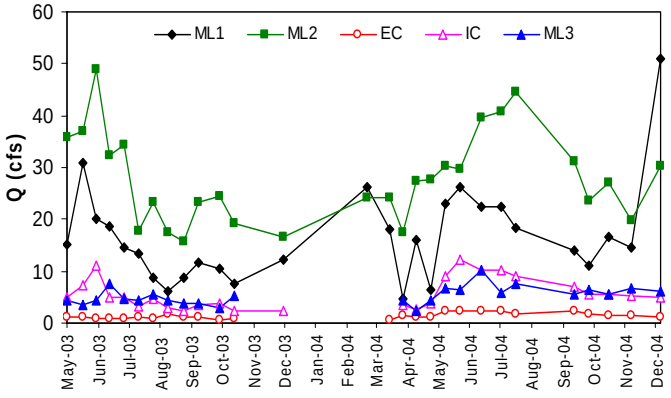

Figure 2. Stream discharge (cfs) at the five monitoring sites.

Discharge rates were highest at the middle Medicine Lodge Creek site (ML2) and lowest in Edie Creek (Table 2). Stream discharge rates in Irving and the ML3 site were not significantly different from each other ($p = 0.582$), but all other site comparisons were significantly different ($p < 0.0001$).

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

Stream	Mean (cfs)	Min (cfs)	Max (cfs)	+/- 95% CI
ML1	16.8	4.7	51.0	3.5
ML2	28.0	15.8	48.8	3.2
ML3	5.3	2.4	10.3	0.7
Edie	1.4	0.5	2.5	0.2
Irving	5.7	2.4	12.1	1.1

Total suspended solids

Total suspended solids (TSS) concentrations in the five sites fluctuated on a seasonal basis. As is common in snowmelt dependent systems, suspended solids levels increased during spring runoff events and declined to low levels throughout the rest of the year (Figure 3). Overall, TSS concentrations at each site were low. The DEQ target of 80 mg/L was exceeded only five times during this project; at the ML1, Edie and Irving sites.

Mean TSS concentrations at the six sites were well below the DEQ target of 80 mg/L (Table 3), but differences between the five sites were detectable. TSS levels were significantly higher in Edie Creek than at the ML2 and ML3 sites ($p < 0.016$). While average TSS levels were nearly as high in Irving Creek, they were not significantly different from the other four sites because of the large variation in TSS observed in Irving Creek. TSS concentrations at ML3 were significantly less than at the ML1 and ML2 sites ($p < 0.0001$) and ML1 and ML2 did not differ significantly in TSS. The relatively high levels of TSS in Edie and Irving Creeks may be due to the steep gradient of the subwatersheds and the impact of livestock grazing along the streams. While all sites met the DEQ target for TSS, further reductions in TSS levels could be achieved by implementing sediment reduction best management practices (BMPs) on Edie and Irving creeks.

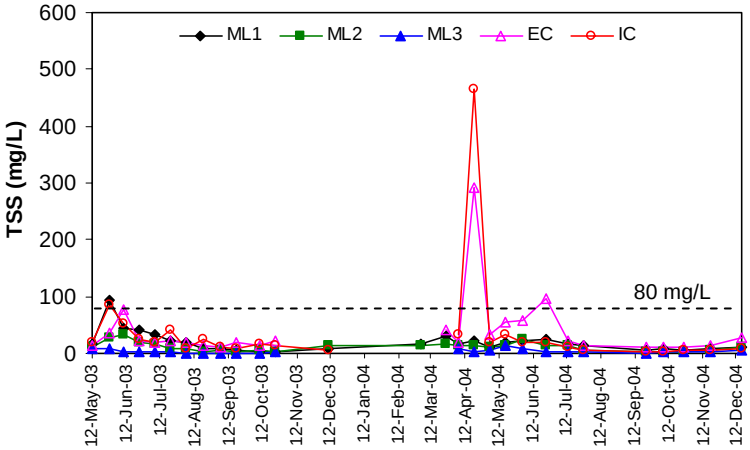

Figure 3. Total suspended solids (TSS) measured at the five monitoring sites from May 2003 to December 2004. The horizontal dashed line represents the DEQ target of 80 mg/L.

Table 3. Mean, minimum and maximum TSS concentrations (mg/L) and 95% confidence intervals.

Stream	Mean (mg/L)	Min (mg/L)	Max (mg/L)	+/- 95% CI
ML1	19.0	3	93	6.7
ML2	11.6	3	34	2.9
ML3	3.9	1	13	1.2
Edie	38.3	10	292	21.5
Irving	36.7	3	464	34.2

Total phosphorus

Total phosphorus (TP) concentrations at the five sites fluctuated throughout the year (Figure 4). Across the five sites TP levels were highest during the late spring and summer months, with the majority of high TP measurements occurring during July. TP concentrations typically declined during fall and winter months, except in Edie Creek where relatively high levels were occasionally observed in the fall and winter months. Overall, TP concentrations were low at all tributaries and only two measurements (Edie Creek) over the two years were greater than or equal to the target of 0.1 mg/L.

On average, TP concentrations at the five sites were well below the DEQ target (Table 4), but differences between monitoring sites were observed. TP levels in Edie Creek were significantly higher than at the Irving, ML2 and ML3 sites ($p \leq 0.0063$). TP

measured at the top Medicine Lodge site (ML3) was significantly lower than at the lowest site (ML1, $p = 0.0057$), but was not different from the middle Medicine Lodge site (ML2).

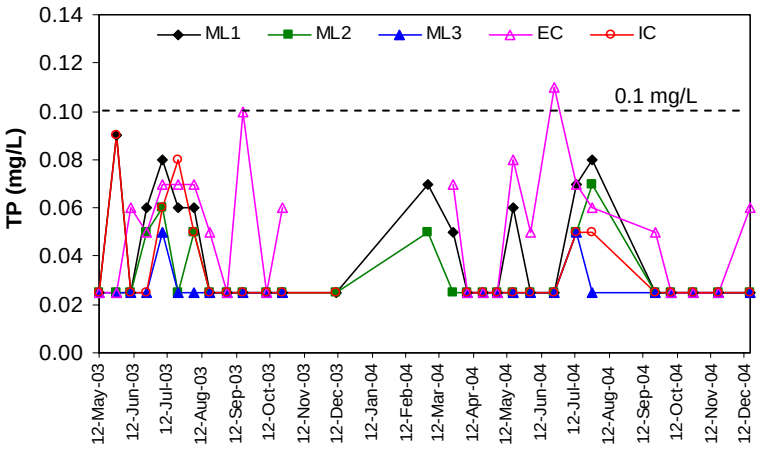

Figure 4. Total phosphorus (TP, mg/L) measured at the five sites from May 2003 to December 2004. The horizontal dashed line represents the DEQ target of 0.1 mg/L.

Table 4. Mean, minimum and maximum TP concentrations (mg/L) and 95% confidence intervals.

Stream	Mean (mg/L)	Min (mg/L)	Max (mg/L)	+/- 95% CI
ML1	0.040	0.025	0.09	0.008
ML2	0.031	0.025	0.07	0.005
ML3	0.027	0.025	0.05	0.003
Edie	0.051	0.025	0.11	0.010
Irving	0.034	0.025	0.09	0.007

Nitrogen

Nitrogen (nitrate + nitrite, mg/L) concentrations at the five sites fluctuated throughout the year and were higher in the upper reaches of the Medicine Lodge Creek and in Edie and Irving creeks than at the lower Medicine Lodge sites (Figure 5). This is contrary to what was expected. It was anticipated that ML3 would have the lowest concentration of all parameters because it was located in the least disturbed portion of the subbasin. The water quality target of 0.3 mg/L was exceeded only occasionally at ML1 (14% of observations) and ML2 (21% of observations) and no seasonal or spatial trends were evident. The number of exceedances were much higher at Edie (100%), Irving (69%) and ML3 (72%), but again no seasonal or spatial trend in nitrogen levels were observed. Every nitrate + nitrite concentration measured in Edie Creek exceeded the target, regardless of season or year.

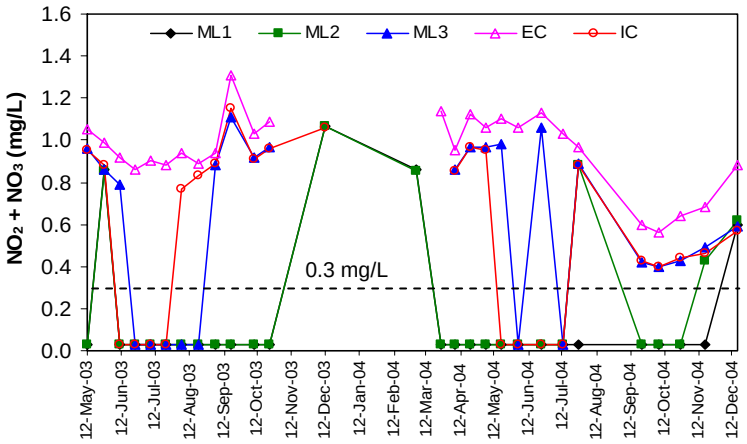

Figure 5. Nitrogen levels (nitrate + nitrite, mg/L) measured at the five sites in the Medicine Lodge subbasin from May 2003 to December 2004. The horizontal dashed line represents the DEQ target of 0.3 mg/L.

Average nitrate + nitrite concentrations at the Edie, Irving and ML3 sites exceeded the DEQ target (Table 5). Significant differences in nitrogen levels were observed between the five sites. Nitrate + nitrite concentrations in Edie Creek were significantly higher than the other four sites ($p < 0.0001$). Average concentrations were very similar at Irving and ML3 and at ML1 and ML2, and the Irving and ML3 sites were significantly higher than the ML1 and ML2 sites ($p \leq 0.0006$). An abundance of aquatic vegetation was observed at the ML3 site, but not in Edie or Irving creeks.

The source of nitrogen in the upper subbasin is hard to determine because ML3, Edie and Irving creeks are located in relatively undisturbed areas compared to the lower reaches of Medicine Lodge Creek. The lower reaches of the subbasin are impacted by irrigated cropland and rangeland, while the upper reaches are primarily rangeland. The high nitrate levels in the upper reaches of the subbasin may be related to groundwater inputs. Nitrates move readily in groundwater and may be entering surface waters via groundwater springs. Ultimately the source is still unknown, but the large influence of groundwater springs in the upper subbasin may indicate how nitrates are entering the system.

Table 5. Mean, minimum and maximum nitrate + nitrite concentrations and 95% confidence intervals.

Stream	Mean (mg/L)	Min (mg/L)	Max (mg/L)	+/- 95% CI
ML1	0.14	0.03	1.07	0.11
ML2	0.19	0.03	1.07	0.12
ML3	0.59	0.03	1.11	0.16
Edie	0.95	0.56	1.31	0.07
Irving	0.56	0.03	1.15	0.16

Temperature

Instantaneous stream temperatures at the five sites exhibited a seasonal pattern. As expected, temperatures were highest during summer months and declined during fall and winter (Figure 6). No temperature measurements exceeded the target for cold water aquatic life (CWAL, ≤ 22°C) during the project. There were exceedances of the temperature target during salmonid spawning periods in Medicine Lodge Creek (SS, ≤ 13°C), but not in Edie or Irving Creeks. Stream temperatures at ML1 and ML2 exceeded the SS 3.6% of the time, while at the ML3 site the temperature target was exceeded 20.0% of the time. Similarly, data collected by the BLM, DEQ and Forest Service between 1997 and 2000 indicated that streams in the subbasin did not exceed the temperature target for CWAL, but often exceeded the SS target.

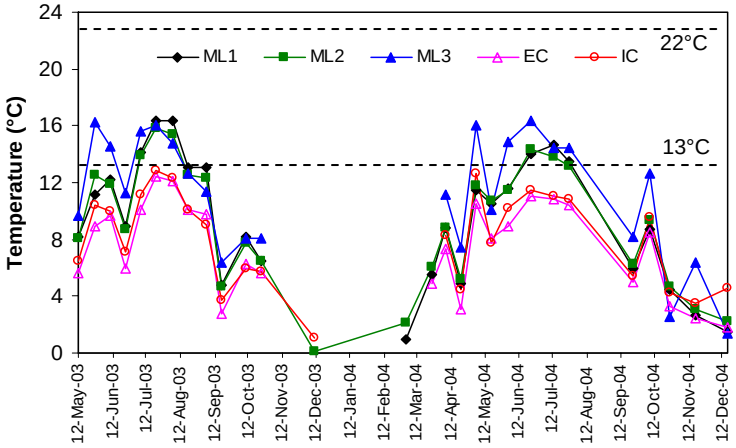

Figure 6. Stream temperature measured at the five sites in the Medicine Lodge subbasin from May 2003 to December 2004. The horizontal dashed lines represent the DEQ target for cold water aquatic life (22°C) and salmonid spawning (13°C).

Average stream temperatures at the five sites were below the CWAL and SS targets, although differences between sites were observed (Table 6). During the critical period for CWAL (June 22 – September 21) temperatures were significantly lower in Edie Creek than in ML1 and ML3 ($p \leq 0.033$) and temperatures in Irving Creek were lower than at the ML3 site ($p \leq 0.018$). During SS periods (May - June 30, Sept. 15-Nov. 15) stream temperatures in Edie and Irving creeks were significantly lower than in ML3 ($p \leq 0.027$), but were not different from the other sites. Stream temperatures at the three Medicine Lodge sites were not significantly different from each other during the CWAL or SS time periods.

Table 6. Mean, minimum and maximum stream temperatures and 95% confidence intervals.

Stream	Mean (cfs)	Min (cfs)	Max (cfs)	+/- 95% CI
Salmonid Spawning				
ML1	9.06	4.5	14.0	1.52
ML2	9.20	4.7	14.3	1.58
ML3	11.08	2.5	16.4	2.22
EC	7.16	2.8	11.0	1.35
IC	7.90	3.7	12.6	1.47
Cold water aquatic life				
ML1	12.90	4.8	16.4	2.19
ML2	12.46	4.7	15.8	2.09
ML3	13.33	6.4	16.4	1.88
EC	9.55	2.8	12.4	1.82
IC	9.96	3.7	12.9	1.71

Conclusions and Recommendations

The results of this monitoring project indicate that water quality targets are being met for TSS, TP and temperature in Medicine Lodge, Edie and Irving creeks. Nitrogen was the only parameter measured that consistently exceeded DEQ's targets.

The seasonal elevation of total suspended solids is common in snowmelt dependent systems. Despite the seasonal fluctuations, TSS levels at all five sites were well below the DEQ target. The streams in this project were originally listed for sediment and each stream received a sediment TMDL from DEQ. According to DEQ, each of the five streams required sediment load reductions (64 - 81% reductions) to meet their

TMDLs. Contrary to DEQ's findings, this monitoring project has demonstrated that TSS concentrations were below the DEQ target at all five of these streams. The lower than expected sediment concentrations measured throughout this project may be the result of conservation efforts that have occurred in the Medicine Lodge subbasin. This project documented that TP concentrations in the five streams were well below the water quality target. TSS and TP are often highly correlated and best management practices (BMPs) that have been implemented to reduce TSS inputs into the system may have additionally worked to reduce TP loads.

Elevated nitrate levels are a common occurrence in streams in the Medicine Lodge subbasin. All sites we monitored exceeded the target for nitrate + nitrite (mg/L) at some point during the monitoring. Average nitrogen measurements from the upper Medicine Lodge site, Edie and Irving creeks exceeded the DEQ target. Despite the high nitrate levels observed in the subbasin, the streams appear to be functioning properly and the impact of the nitrogen on the system is not clear. An abundance of aquatic vegetation was observed at the ML3 site, but measurements of dissolved oxygen at the site indicated that fish habitat was not impaired.

The high nitrogen may be due to cattle grazing that occurs on lands above and adjacent to the sites. However, if grazing was a major influence on water quality, then elevated levels of sediment (TSS) and total phosphorus (TP) would be expected in the streams. Instead, TSS and TP concentrations were low, making it difficult to fully attribute the elevated nitrate levels to the presence of grazing livestock. Additionally, stream visual assessments (SVAP) that were conducted on Medicine Lodge, Edie and Irving creeks suggested that 75% of the streams were in good or fair condition (Traher 2002). This indicates that cattle grazing was not having a significant impact on the stream corridor.

The high nitrate levels in the upper Medicine Lodge subbasin may also be related to groundwater inputs. Nitrates move readily in groundwater and may be entering surface waters via groundwater springs. Ultimately, the source is still unknown, but the influence of groundwater in the upper reaches of Medicine Lodge, Edie and Irving creeks may indicate how nitrate is entering the system. Further monitoring and evaluation of nitrate levels will be necessary to determine the source of nitrogen in these streams and the impact on stream function. These efforts should include groundwater monitoring and soil sampling.

Overall, water quality in the three streams monitored appeared to be good. The source of elevated nitrogen should be further investigated through a review of the geology, soils and historical landuse in the subbasin.

Acknowledgements

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