Total Maximum Daily Load for Sediments in the Waters of Lake Creek, Idaho

TMDL Summary

Waterbody:	Lake Creek, Idaho
Water Quality-limited?	Yes
Hydrologic Unit Code:	17010303 (Coeur d'Alene Lake)
Criteria of Concern:	Narrative criteria for sediment
Designated Uses Affected:	Cold water aquatic life
Environmental Indicators:	Instream total suspended solids (TSS) concentration
Major Source(s):	Cropland erosion and mass wasting
Loading Capacity:	276.1 tons/year
Wasteload Allocation:	0 tons/year
Load Allocation:	276.1 tons/year
Margin of Safety:	0 tons/year (included implicitly)
Necessary Reduction:	71%

Introduction

Lake Creek is located in the Coeur d'Alene basin in northern Idaho near the Washington state line and drains into Windy Bay on the western side of Lake Coeur d'Alene. The watershed of the impaired segment of Lake Creek is approximately 21,560 acres (33.7 mi^2), with 27 percent (5,748 acre [9 mi^2]) located in Spokane County, Washington. The remainder of the watershed is located in Kootenai County, Idaho, with the majority of the Lake Creek drainage area located on the Coeur d'Alene Indian Reservation. The watershed landuse is primarily agriculture (36 percent) and forest (60 percent) with small portions of urban areas.

The portion of Lake Creek located on the reservation is included on the State of Idaho's 1998 303(d) list as being water quality limited because increased sediment loadings have reduced the quality of pools necessary for fish spawning and winter survival. Sediment affects aquatic life uses in several ways, including the following:

- Sediment deposition can fill pools, reducing aquatic habitat, particularly for refuge and rearing.
- Sediment deposition can fill interstitial spaces between gravel, reducing spawning habitat by trapping the emerging fish and reducing the exchange of oxygen necessary for fish embryos.
- Suspended sediment and turbidity can prevent fish from seeing food in the water and can clog their gills.
- High levels of suspended sediment can also result in fish avoiding the stream.

Applicable Water Quality Standards and TMDL Target

The Couer d'Alene Tribe (CDAT) has adopted water quality standards for the waters within its Reservation. Both the tribal and state water quality standards contain narrative criteria for the protection of waters from excess sediment.

The tribe's water quality criteria for sediments are as follows:

> *All surface waters of the tribe shall be free from anthropogenic contaminants that may settle and have a deleterious effect on the aquatic biota or that will significantly alter the physical and chemical properties of the water or the bottom sediments.* (CDAT, 1999)

The state's water quality criteria for sediments are as follows:

> *Sediment shall not exceed quantities specified in Section 250, or, in the absence*

of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350.02.b. (IDEQ, 2003a)

This TMDL is developed to meet these criteria and protect designated uses in Lake Creek, based upon agreement from the involved agencies (CDAT, USEPA Region 10, Idaho DEQ). Designated uses include domestic water supply, agricultural water supply, recreational and cultural use, bull trout aquatic life use (Upper Lake Creek), and cutthroat trout aquatic life use (Lower Lake Creek).

The TMDL is developed to meet an instream TSS target concentration representing levels acceptable for designated use support.

The TSS target was established from a range of values typically maintaining good or moderate fisheries (EIFAC, 1965). The European Inland Fisheries Advisory Commission report (EIFAC, 1965) reviewed literature on suspended solids effects on fisheries in an attempt to define water quality criteria for suspended solids and fisheries. The report indicated that a relationship between solids concentration and risk of fisheries damage could not be precisely defined, but the available information could be used to establish categories of risk to fisheries with associated typical ranges of concentrations. Based on the information included in EIFAC (1965), the Environmental Studies Board of the National Academy of Sciences (NAS and NAE, 1973) recommended the following ranges of TSS concentrations and the corresponding effects on aquatic communities:

- <25 mg/L = No harmful effect on fisheries
- 25–80 mg/L = Slight effect on production
- 80–400 mg/L = Significant reduction in fisheries
- >400 mg/L = Poor fisheries

Based on these ranges, a TSS target of 40 mg/L was selected for Lake Creek. The ranges identified in EIFAC (1965) and NAS and NAE (1973) represent a persistent instream concentration that occurs frequently, rather than a maximum instantaneous concentration that may occur infrequently and present less of a risk to the aquatic communities. Because the Lake Creek TMDL uses a constant, instantaneous concentration of 40 mg/L under all flows for the identification of loading capacities, the 40-mg/L concentration is assumed acceptable, and even conservative, for resulting in typical or "average" instream TSS between 25 and 80 mg/L.

SOURCE ASSESSMENT

Point Sources

No permitted point sources discharge in the watershed of the impaired segment of Lake Creek.

Nonpoint Sources

The Coeur d'Alene Tribe Water Resource Program produced a watershed assessment report (Coeur d'Alene Tribe, 2000) that estimated sediment contributions from the various nonpoint sources in the Lake Creek basin. The watershed assessment identified erosion from cropland as the primary nonpoint source of sediment within the watershed with smaller contributions from roads, soil creep, and mass movement of soils.

LOADING CAPACITY: LINKING WATER QUALITY AND THE SEDIMENT SOURCES

Instream solids concentrations are highly variable based on flow and antecedent conditions, and instream flows vary depending on weather and watershed conditions. To capture the inherent variability of flow and instream sediment conditions in Lake Creek, this TMDL uses observed flow data and a TSS target to statistically establish loading capacities for various flow ranges in Lake Creek.

Observed flows were distributed based on their frequency of occurrence to establish a flow regime for the watershed, and 10 distinct flow ranges were established. The TSS target and observed flows were then used to calculate loading capacities for each flow range. To identify the load reductions needed to meet the loading capacities, it was necessary to determine the existing TSS loadings in Lake Creek. Because instream TSS data are limited and turbidity data have been available almost daily

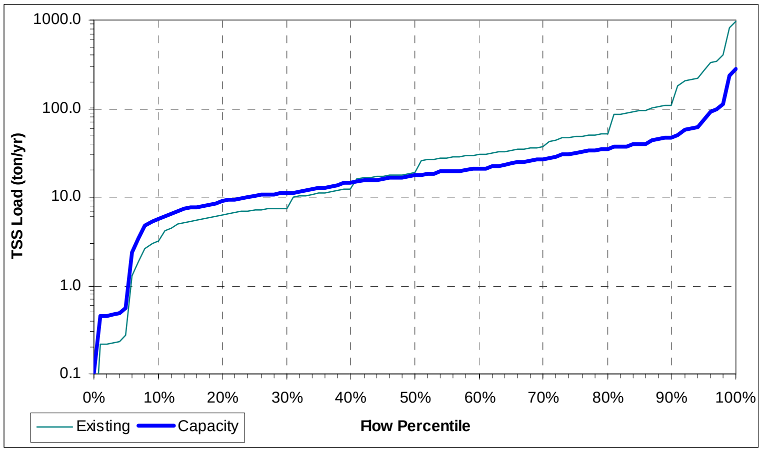

Figure 1. TSS existing loads and loading capacity curves.

since 1996 and for a wider range of flows, turbidity data were used along with flow as the basis for identifying the existing sediment loadings. For each of the 10 flow ranges, a representative existing turbidity concentration was identified. These turbidity concentrations were then converted to TSS concentrations based on a correlation equation determined by using observed monitoring data. The TSS concentrations for each flow percentile range were then used to establish existing TSS loadings for the Lake Creek watershed. Figure 1 presents the loading capacity and existing loading curves developed for the Lake Creek watershed.

DATA USED IN ANALYSIS

All the data available for the Lake Creek watershed was evaluated for theit appropriateness for use in this TMDL analysis, specifically for the identification of a TSS-turbidity relationship and the subsequent evaluation of existing loadings.

TSS and Turbidity Relationship

The Lake Creek TMDL establishes a TSS target to represent the narrative water quality standards. However, TSS data are limited in the Lake Creek watershed, whereas turbidity data have been available at two stations almost daily since 1996. Having data throughout a wide variety of flows provides a more representative picture of the conditions in the watershed and captures the variability of instream conditions. For this reason, instead of using the limited TSS data to estimate existing conditions in the watershed, turbidity was used as the basis for identifying existing TSS values.

Paired TSS and turbidity data were isolated to establish a relationship between the two parameters so that TSS values could be predicted based on the more readily available turbidity data. Paired TSS and turbidity data are available for the Emtman (upstream) and Godde (downstream) stations and a station on Bozard Creek, representing a combination of data from both the Coeur d'Alene Tribe and the Kootenai-Shoshone Soil Conservation District (KSSCD). There are 67 paired readings at the Godde station, available from 1996 to 2002 and for all months, 28 at the Emtman station and 24 at the Bozard Creek station. All of the Lake Creek watershed paired data were used to establish the turbidity-TSS relationship (Figure 2) and the available turbidity and flow data were used to subsequently evaluate the existing TSS conditions.

Evaluation of Existing Loading Conditions

To evaluate the loading conditions in the Lake Creek watershed, it is important to have data that appropriately reflect the range of water quality and flow conditions that occur in the creek. Turbidity and flow data were evaluated for the entire period of record to evaluate any identifiable water quality trends.

Evaluation of the data indicated an obvious increase in turbidity in October 1997 at the Goode station (Figure 3). Corresponding turbidity and flow values were evaluated to investigate potential explanations

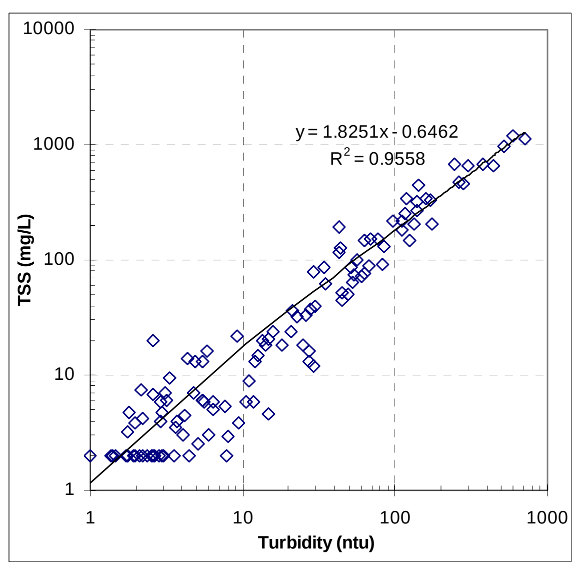

Figure 2. TSS versus turbidity in Lake Creek.

for this variation in the data. As shown in Figure 3, turbidity and flow follow a similar (and expected) pattern of turbidity increasing with flow throughout the majority of the period of record.

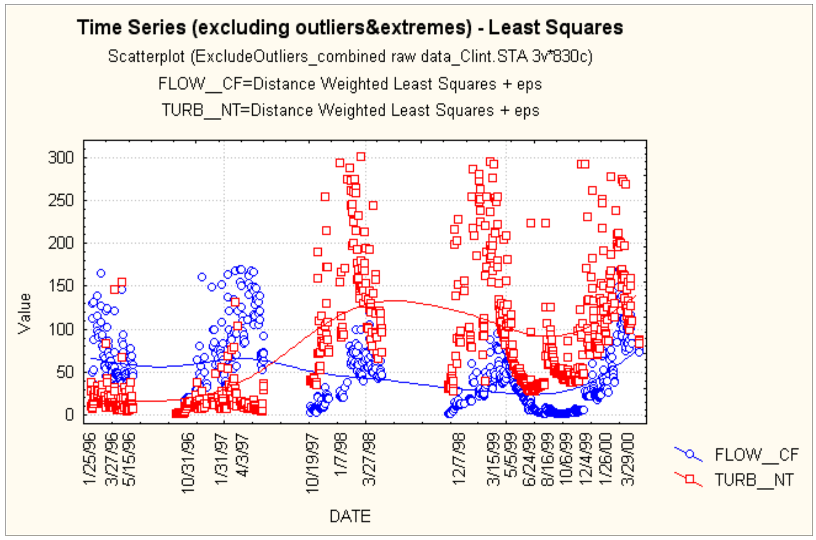

Figure 3. Correlation of flow and turbidity in Lake Creek

However, data collected after October 1997 show an increase in turbidity readings, with flow remaining comparable to or below pre-October values. The pattern of turbidity increasing with higher flows flow and decreasing with lower flows continues but turbidity values are a magnitude higher than previous measurements. Discussions with the Lake Creek TMDL Advisory Committee indicated that a major rain-on-snow event in the watershed produced flood conditions in early 1997. Logging at a parcel of forest property near the Godde station also occurred during the spring of 1997, likely increasing sediment runoff to the stream. The anomalies in the flow-turbidity relationship could be attributed to extreme flow conditions and the subsequent, temporary alteration of the environment due to the rain-on-snow events, as well as increased sediment runoff and delivery due to the isolated logging activities.
The monitoring equipment at the Goode station is located in a portion of the stream close to the culvert discharging the muddy runoff from the logging site. When the logging runoff enters the stream, it mixes with and likely becomes diluted by the stream flow with lower sediment concentrations. However, because of its location, the equipment is likely capturing unmixed conditions in the stream and is measuring concentrations dominated by the logging discharge and its elevated sediment concentrations. Because the data measured during these conditions are considered not representative of the actual stream conditions at the Goode site, data from October 1997 through June 2001 were excluded from the estimation of existing loading in the Lake Creek TMDL analysis.

TMDL ALLOCATIONS

A TMDL is equal to the sum of the wasteload allocations (WLA) for point sources and the load allocations (LA) for nonpoint and background sources and includes a margin of safety (MOS) to account for any uncertainty in the relationship between pollutant loading and the water quality of the receiving waterbody.

Because no permitted point sources are discharging in the watershed of the impaired segment of Lake Creek, the wasteload allocation for this TMDL is zero. Therefore, the entire loading capacity of 276.1 tons/yr is grossly allocated to all nonpoint sources of TSS loading in the watershed. Table 2 presents the overall TMDL and Table 3 presents the load allocations and associated load reductions for each analyzed flow range.

Table 2. Sediment TMDL for Lake Creek

Source	Existing TSS load	Estimated percent reduction	Allocated TSS load
Nonpoint Sources:			
Lake Creek watershed	956.4 tons/yr	71%	276.1 tons/yr
Point Sources:			
N/A	0 tons/yr	0%	0 tons/yr
Total Existing Load	**956.4 ton/yr**	**Load Allocation**	**276.1 tons/yr**
Total Annual Load Reduction = 71%		**Wasteload Allocation**	**0 tons/yr**
		Margin of Safety[1]	**0 tons/yr**
		TMDL = Loading Capacity =	**276.1 tons/yr**

[1] MOS was included implicitly using conservative assumptions

Table 3. Summary of Lake Creek TMDL load allocations and associated load reductions

Flow Percentile	Flow (cfs)	Load[1] (ton/yr)	Capacity[1] (ton/yr)	Percent Reduction[1]	Cumulative Load[2] (ton/yr)	Cumulative Capacity[2] (ton/yr)	Percent Reduction[2]
10%	28.6	3.2	5.6	-	3.2	5.7	0
20%	44.7	3.1	3.2	-	6.3	8.9	0
30%	55.5	1.1	2.1	-	7.4	11.0	0
40%	73.9	5.0	3.6	28	12.4	14.6	0
50%	89.1	6.3	3.0	53	18.7	17.6	6
60%	107.4	11.4	3.6	68	30.1	21.2	29
70%	135.3	6.6	5.5	17	36.7	26.7	27
80%	178.4	16.0	8.5	47	52.7	35.2	33
90%	239.5	56.5	12.0	79	109.2	47.2	57
100%	1,404.9	853.5	228.9	73	962.7	276.1	71

[1] Represents loads for the flow range (e.g., 30th–40th percentile range).
[2] Represents cumulative loads through the maximum percentile of the range (e.g., 0–40th).

Seasonality

A TMDL must include consideration of seasonality in the analysis. Although this TMDL does not specifically establish seasonal TSS load allocations, it is based on a representative flow regime in the Lake Creek watershed. By using flow-based loadings, the TMDL inherently accounts for seasonal variation due to the seasonal influences on weather and, therefore, flow.

Margin of Safety

A TMDL must also include a margin of safety (MOS) to account for any uncertainty in the relationship between pollutant loading and the water quality of the receiving waterbody. The MOS for the Lake Creek TMDL was included implicitly in the analysis through conservative assumptions.

MONITORING PLAN

The Coeur d'Alene Tribe plans to continue its ongoing water quality monitoring in the Lake Creek watershed, summarized in Table 4. In addition to water quality parameters, habitat indicators will be incorporated into the monitoring plan to directly measure fisheries habitat quality and designated use attainment. Indicators might include channel stability indices, percent of fine sediment, and riffle:pool ratios.

Table 4. Coeur d'Alene Tribe's monitoring plan

Site	Parameter	Frequency
Upper Lake Creek	Discharge, temperature, turbidity, pH, dissolved oxygen, conductivity	Biweekly, March 1 through October 31, and peak flow events
	TSS and turbidity	Rain-on-snow events (three events between November 1 and June 1)
Bozard Creek	Discharge, temperature, turbidity, pH, dissolved oxygen, conductivity	Biweekly, March 1 through October 31, and peak flow events
Lower Lake Creek	Discharge, temperature, turbidity, pH, dissolved oxygen, conductivity	Biweekly, March 1 through October 31, and peak flow events
	TSS and turbidity	Rain-on-snow events (three events between November 1 and June 1)

IMPLEMENTATION PLAN

Although not legally required, an implementation plan is crucial to the success of the TMDL. An implementation plan for the Lake Creek TMDL will likely be developed by the Coeur d'Alene Tribe and will evolve as the TMDL is finalized. The plan will include specific control actions to reduce sediment loads entering Lake Creek, parties responsible for implementing the controls, timelines, and progress milestones. Control actions will focus on reducing sediment inputs from agricultural sheet and rill erosion and mitigating flow disturbances and sedimentation due to forest roads. Specific actions may include converting land to permanent crop covers (e.g., bluegrass), establishing buffer strips, and such agricultural BMPs as strip cropping, no-till farming and various structural practices. Additional control actions that would enhance the salmonid habitat are restoring riparian zones and augmenting baseflow of Lake Creek and tributaries.

REFERENCES

NAS (National Academy of Sciences) and NAE (National Academy of Engineering). 1973. *Water quality criteria 1972*. U. S. Environmental Protection Agency, Ecological Research Series Report R3-73-033, Washington, DC.

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